# ANNALS OF SURGERY

VOL. XLI MAY, 1905 No. 5

## ORIGINAL MEMOIRS.

### ACTINOMYCOSIS.[1]

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THE purpose of this paper and demonstration is to present the clinical side of the disease, actinomycosis, as it occurs in man, and as illustrated by six cases which I have recently had under observation.

I desire at the outset to disclaim any pretensions to an exhaustive knowledge of this subject from a pathological and biological stand-point, and present this work as illustrative of the working knowledge, or at least part of the working knowledge, which the surgeon should possess to enable him to successfully recognize and treat these cases occurring in his actual practice.

#### HISTORICAL.

Langenbeck first noted the sulphur grain-like bodies of actinomycosis in an abscess, in 1845; he did not recognize their true nature.

Bollinger, in 1877, recognized the vegetable organism of ray fungus as the cause of lumpy jaw in cattle.

[1] Read before the Chicago Surgical Society, December 5, 1904.

Israel, in 1878, recognized the ray fungus as the cause of disease in man.

Belfield first recognized the ray fungus in this country in lumpy jaw in cattle, and Murphy reported the first case of actinomycosis in man in this country.

The ray fungus is difficult to classify, and its classification has been a matter of much dispute. Hektoen believes that it belongs either to the simple moulds or constitutes a distinct group between moulds and bacteria.

The ray fungi are common in nature, being found in air, water, and soil, and especially as a rust on various grains and grasses. A great many varieties have been isolated, some simply saprophytic and harmless, others pathogenic. Of the pathogenic forms, two interest the clinician,—the actinomycosis generally recognized as such, and the altered form, which produces Madura foot.

The ray fungus develops from a small, round spore into cylindrical threads, which branch and form a net-work. Each single thread, with its branches, represents one whole single organism. The mass of considerable size which presents the picture of a central mass with radiating clubs is a colony of the organisms, or a group of colonies.

The ray fungus gains access to the body either through the mouth or pharynx mucosa, the respiratory tract, the alimentary tract, or the skin. Probably a lesion of the protecting epithelium must exist through which the fungus can enter, or the fungus is carried into the tissues by some foreign body, as a bit of straw or grass, or splinter of wood, or, as in one case of Madura foot, by a prong of a pitch-fork. The fungus produces granulomatous swellings in the tissues, accompanied sooner or later by suppuration and usually with mixed infection. The fungus is found in the pus, either as the ray fungus colonies or granules, which can be seen with the naked eye, or as the thread-like bodies of the single organisms to be seen on staining. In the granulation tissue the same forms can be found, but more sparingly.

The diagnosis of the lesion must be made absolute by the

finding under the microscope of the typical pictures of ray fungus colonies or threads, either in the pus or the granulation tissue. It is sometimes very difficult to do this, and a fairly satisfactory clinical diagnosis can be made from the history of the process, more or less chronic, the granulation tissue, the suppuration, and the presence in the pus and tissues of the so-called sulphur grain bodies, or, as I think they should better be described, as very minute fish-egg-like bodies—gray or translucent in appearance. In my cases I have found the actinomycotic granules gray or translucent much oftener than sulphur or yellow in color.

In this connection I want to call attention to one source of error which we have recently met with. Last week a case of an extensive ulcerative and suppurative lesion of the jaw and cheek was presented in my clinic for diagnosis. It was very suggestive of actinomycosis. I at once carefully examined the pus macroscopically, and found many bodies identical in size and shape and consistency with the granules found in actinomycotic pus. This seemed to make the diagnosis almost certain. However, an examination of a piece of tissue showed that it was an epithelioma with pus infection, and that these suspicious bodies were epithelial pearls which, with the breaking down of the infected neoplasm, were freed and floated away in the pus. Another source of error is the finding of vegetable organisms in the saliva or pus about a mouth lesion, or in fæcal matter in an abdominal lesion, suggestive of actinomycosis, but in reality a mere accidental finding, with no relation to the disease.

The pus of actinomycosis has a distinctive odor, which certainly can sometimes be detected by an acute olfactory sense. It is said to be an earthy smell, similar to that found coming from freshly turned-over soil. Two of my force at the Presbyterian Hospital have distinctly recognized this odor in two cases, and suggested a diagnosis from it. In another case, where an abscess from an appendix or cæcal actinomycosis broke into the vagina, the mother of the patient recognized and described this peculiar odor.

In clinical work the crushing of one of the granules with a cover-glass and inspection with a four eyepiece, and first with a three, and then a seven objective, without any staining often gives a satisfactory picture and a definite diagnosis, from the finding of the ray arrangement with clubs or fragments with threads and coccus-like bodies.

We have learned, however, not to expect to find the beautiful and clear radiating clubs pictured, especially from cases of bovine actinomycosis. Instead of this, the picture is rather blurred; often the organisms have undergone some degenerative process, which leaves nothing distinctive, and it may be necessary to search for a very considerable period before a sufficiently characteristic body is formed. I am rather led to believe that the fact just cited, *i.e.*, the difficulty of finding a clear, distinct picture of the fungus under the microscope, has frequently been the cause of error in diagnosis, and responsible for failures to recognize the lesion, when, in fact, it was present and typical. As an instance, I will say that an exceptionally well qualified diagnostician was given some pus from one of our cases, a case of lung actinomycosis. There were present many of the granules. After working over it for two hours, he reported that it was not actinomycosis, as far as he could determine, although both before and after the examination we found typical ray fungi in the pus from the same source. With the clinical picture typical, the diagnosis can be made from the thread-like forms. Cultures can be made on glycerin-agar at body temperature. The stain which Baracz recommends is gentian violet (Gram). In the tissues hæmatoxylin and eosin answer very well. Care should be taken in handling this material in the laboratory, so as to avoid possible infection of the laboratory worker; although I can find no recorded instance of such a case, yet I have had a personal communication of such a case occurring in a neighboring city.

In this same connection might be mentioned the fact that there is no positive evidence of infection of the human being from eating the meat of infected cattle, or consuming the milk or milk products from infected cattle.

One must not conclude, however, that this does not occur, and until we have much fuller knowledge than we possess at present the greatest possible precautions against such a contingency should be insisted upon, especially in view of the apparent great frequency of the disease in this locality at the present time. Indeed, the great number of lumpy-jawed cattle slaughtered in Chicago, and the apparently large (though not generally recognized) number of human victims from the same disease, suggest so strongly a possible connection that even in the absence of positive proof the greatest care should be exercised by the authorities to eliminate such a source of contamination.

We can well afford to take such a position in regard to lumpy jaw, in view of the fact that such a great authority as Robert Koch will not accept as a demonstrated fact the infection of a human being by bovine tuberculosis, not even in a single instance, and yet the opinion of most clinicians is overwhelmingly in favor of the probability of such a source of infection in a large percentage of our cases.

Clinically, actinomycosis appears under four different forms, from four different routes of infection:

1. Head and neck actinomycosis, with infection from mouth and pharynx.

2. Chest actinomycosis through the respiratory tract.

3. Abdominal actinomycosis, with infection probably always through the alimentary canal, possibly through the genital tract of the female.

4. Actinomycosis of the skin.

The ray fungus can without much doubt gain access to the tissues through a mucosa and leave at the point of entrance little or no discernible lesion. The reported cases of primary actinomycotic lesion of the brain, liver, spleen, etc., are probably explained in this way, that the fungus passed through the mucosa of the pharynx or middle ear in the brain cases, and through the intestinal mucosa in the abdominal cases, and developed in brain, liver or spleen distinct lesions, without any distinct lesion at point of entrance.

The lesions formed are primarily granulation tumors, or at least granulation tissue; thus, from a primary focus it extends in all directions, irrespective of tissues, by continuity. The lymphatic glands are seldom involved, that is, the fungus does not produce a lymphatic invasion; at least this is rare. We have, however, had one case of glandular involvement, and present a specimen from the inguinal glands of a fatal case of rectal actinomycosis.

Beside regional involvement, a pyæmic form is found, due to the breaking into a vein of a focus of the disease, the spores thus gaining access to the general circulation or portal circulation, and producing the picture of an actinomycotic pyæmia, with multiple foci in the lungs, liver, spleen, etc.

The frequency of occurrence of the disease in the various regions is found to be, roughly speaking, about 50 per cent. of head and neck actinomycosis, from 15 to 20 per cent. of chest cases, from 20 to 25 per cent. of abdominal cases, about 2 per cent. of skin cases, and a small balance where it is difficult to determine the route of infection.

I am satisfied that the disease is quite common, and is often not recognized. I have seen six cases recently, in little over a year; most of them were not recognized by the attending medical men, and in several instances the attendants were surgical experts. Personally, I feel that I recognized the first case of this growth rather by accident, and recognized the others because my attention had been called especially to the subject. The moral is that the attention of the profession must be called to the subject repeatedly, so that they will be always on the lookout for the disease. Certainly this is important from at least two stand-points:

1. If the disease is recognized, much can often be done by proper treatment.

2. If the disease is in fact as common as I am led to believe, a demonstration of this fact will probably lead to its more careful study, and possibly, I shall say probably, the development of a scheme of prophylaxis which will reduce the dangers from this source.

The prognosis of ray fungus disease is an interesting topic. Formerly, it was regarded as exceedingly bad. It is now known that many cases recover spontaneously, as do ordinary abscesses, either from pus infection or from tuberculosis. Where the lesion is so situated that the entire focus can be safely subjected to surgical treatment, as in head and neck and skin cases, the prognosis is excellent. Where this cannot be done, as in lung and extensive abdominal actinomycosis, the prognosis is exceedingly grave, but not hopeless. The treatment which was at first recommended, *i.e.*, wide extirpation of the involved tissue, as in carcinoma, is no longer regarded as necessary. The laying open of the focus or foci, the scraping away of the granulation tissue with a sharp spoon, the touching of the surface with nitrate of silver stick, the packing with iodoform gauze, the use of iodide of potash internally in good-sized but not necessarily massive doses, and eventually, if necessary, the use of the X-ray, offer a plan of treatment which will succeed if the lesion is thoroughly accessible. In lung cases we must be satisfied with curetting the accessible portions of the lesion in cases where the process has extended to the chest wall, and using iodide of potash and the X-ray. Here the prognosis is bad, a small percentage, probably less than 10 per cent., being saved.

In abdominal cases, where the lesion is limited and can be safely excised, as where it is limited to the appendix, excision, which offers an excellent prognosis, is in order. Some of the cases of actinomycosis of the appendix and intestine simulating appendix abscess recover with drainage of the abscess, without further treatment. Usually the case is not as fortunate, and second and third and multiple operations for opening abscesses and curetting sinuses will be necessary. Solutions, as recommended by Baracz, of 20 per cent. of nitrate of silver, should be carried into all the fistulæ and pockets, and the iodine treatment and X-ray employed. The prognosis in abdominal cases, roughly speaking, is 70 per cent. fatal and 30 per cent. recoveries. The skin cases give an entirely favorable prognosis when recognized and properly treated.

The pyæmic cases are hopeless. The prognosis is undoubtedly influenced more by the resisting powers of the individual than by any other factor; certainly more by this than by any scheme of treatment. This is well shown by the cases which go on to spontaneous cure after the evacuation of an abscess without any further treatment.

Treatment, however, is of absolute and demonstrated value; and it is, I repeat, of great importance that the correct diagnosis be made, so that the patient may be given the benefit of such appropriate and valuable treatment.

Of first importance is the opening of the focus and drainage, as in any abscess. Second, removal by a sharp spoon of the granulation tissue produced by the lesion. Third, the destruction of the fungi allowed to remain in the tissues by nitrate of silver in stick or solution, or by iodine. Fourth, maintenance of drainage by iodoform packing. Fifth, the use of iodide of potash either internally or as 1 per cent. injection into the tissue surrounding the focus, or by cataphoresis. Senn has employed it in both blastomycosis and actinomycosis. The veterinary surgeons employ iodide of potash in interrupted doses. The same plan may be used with the patient. Use the drug for a week, interrupting for three to five days. It is thought that better results are thus obtained on the theory that the spores are more resistant than the adult thread forms, and that the days in which the drug is not used the spores find an opportunity to develop into the adult forms, which are more easily destroyed by the action of the drug.

The X-ray seems to be of distinct value in the treatment of actinomycosis. In the treatment of blastomycosis, the combined treatment of the X-ray and iodide of potassium has proven to be of the greatest value. This clinical fact led me to do some experiments, in which I was assisted by Professor Walter S. Haines and Dr. Joseph F. Smith. The most important result which we obtained was this, that the X-ray liberated free iodine in solutions of iodide of potash, and we believed that it was fair to conclude that given a patient with a lesion of blastomycosis or actinomycosis, saturated with

iodide of potassium and exposing the lesion to the X-ray, free nascent iodine is liberated in greater amounts than without such exposure, at and about the seat of the lesion, and that the apparent striking clinical results from such combined treatment, which I call radio-chemic treatment, found at least a possible explanation.

It would seem as though our knowledge of actinomycosis is at present limited. From the very considerable progress which we have made in the last few years in the way of bettering the prognosis by improved methods of treatment, we are justified in hoping that a further study of the disease may result in the discovery of knowledge which will enable us to more easily recognize the condition, and which will furnish us the means of prophylactic treatment and curative treatment, which will eradicate the trouble.

CASE I.—H. E., aged eleven years; school-boy. Family history negative. Previous history: Pneumonia when a year and a half old. Measles at two years. Present trouble: Four days previous to admission to hospital the patient received a blow in the abdomen. The same evening, after eating a hearty meal, he complained of pain in right abdomen and in epigastrium. Pain increased the following day, reaching its maximum the second day. There was some nausea and diarrhœa. The next two days the pain gradually diminished in severity. Patient had not previously suffered from similar attack.

June 15, 1904. Admitted to the hospital, complaining of only slight abdominal distress. Examination showed patient to be a fairly well nourished boy. Abdomen was symmetrically distended and tympanitic, except for dull area in right lower quadrant. An indefinite mass could be made out in this region, which was not very tender. No bulging felt per rectum. Blood count showed 62 per cent. hæmoglobin, and leucocytes 23,500. Urine showed hyaline and granular casts. Temperature, 101° F.; pulse, 112; respirations, 30.

June 16. Muscle-splitting incision made over swelling and pus evacuated and drainage inserted.

June 17. Temperature was 101° F., and on subsequent days

gradually receded to 99° on June 21. Temperature then began a gradual ascent, and remained between 101° and 102.5° F.

White counts were as follows: June 27, 22,250; June 28, 22,800; June 29, 23,700; July 1, 23,950.

About June 28 a swelling was noticed in right hypochondriac region. This was firm and slightly tender to touch. It increased in size in next few days.

July 1. Incision was made into this mass, and thick pus evacuated, in which were noticed distinct yellow granules. Under the microscope these proved to be colonies of the ray fungus. Drainage was instituted. Temperature remained about 100° F. for next few days, and July 7 went to 103° F.

July 8. Stomach contents were noticed on dressings from upper wound. Nutrient enemata then commenced, with nothing by mouth.

July 8. Leucocytes, 20,800.

July 11. Gradual return to mouth feeding begun. X-ray treatment every second day.

July 16. Potassium iodide commenced, gr. v, t. i. d., increasing dose by one grain daily till twenty grains were reached.

July 18. Leucocytes, 13,250. Patient then went on to complete recovery, and was discharged from hospital August 10. Continued potassium iodide, grs. x, t. i. d., at home.

January 1, 1905. Patient in good condition. No evidence of actinomycosis. In December had an attack of pain and vomiting, which lasted a few hours. Patient again placed on potassium iodide.

Case II.—V. V., aged forty years; Swiss; occupation, car repairing. Residence, Hammond, Ind. Family history negative. Previous history: Malaria twenty years ago. No venereal infection. Present trouble began three years ago, with severe pain in right lower chest. It kept him from work for about three weeks. He then considered himself well, and continued to work till two years ago, when he had a return of the trouble, and a "sore spot" was noticed near the sixth rib in the mammillary line on right side. The tenderness would nearly disappear at times, and he would be able to work. About one year ago a lump appeared on chest-wall at seat of the tenderness. This gradually increased in size until seven weeks ago, when it was opened and pus escaped. Since then there has been a continual discharge of pus.

Patient admitted to hospital August 31, 1904. Physical examination at that time showed a reddened area and discharging sinus at fifth interspace in mammillary line on right side. Dulness was present, and breath and voice sounds absent below sixth rib, behind on right, and below fifth rib anteriorly. Examination otherwise negative. Pulse, 100; temperature, 98.8° F.; respirations, 24.

September 1. Resection of sixth rib in axillary line on right side. A very thick pleura was cut through and adherent lung freed by finger. About one and one-half ounces of pus escaped. Sinus curetted. Temperature following operation was 100° F., and subsequently fluctuated for several days, the highest recorded being 101° F. Respirations did not go above 28. Temperature then gradually came down to normal, and has remained so except for occasional rise to 99° F. and 99.2° F.

September 10. Sputum was brownish-yellow and contained mustard-seed-like granules, which, under the microscope, proved to have the typical ray fungus appearance.

September 12. Bodies were again found in the sputum and clubbed rays demonstrated under the microscope.

September 13. Began potassium iodide, ten grains three times daily, increasing dose by two grains daily. Discontinued September 18, on account of stomach disturbance.

September 24. Potassium iodide again, taking grs. v, t. i. d. Discharged from hospital, September 26, 1904. Weight is increasing about two pounds a week under the iodide. Expectoration is diminishing; still find ray fungi. Temperature now normal, except for occasional slight evening rise. Strength improved so that he has returned to work. Prognosis is, of course, very grave, as in all cases of lung actinomycosis, and yet the marked improvement in this case is encouraging.

Case III.—E. J. G., aged thirty-one years; Augusta, Ill.; farmer. Family history negative. Previous history: Pneumonia eight years ago. Denies any venereal infection.

Present trouble began two months ago, when patient first noticed a "kernel" in left side of neck, about one inch below inferior maxilla and one and one-half inches from median line. When first noticed, it was about the size of a hazel-nut, and not painful to pressure. This gradually increased in size, and for the past month has been the seat of more or less pain. Patient has

" felt hot in face" at times, but temperature has never been taken. Has no cough. Expectorates rather frequently, and occasionally sputum is blood-streaked. Patient admits habit of chewing grain and spears of grass. Admitted to hospital December 6, 1902.

*Examination.*—General appearance excellent. Weight, 197 pounds. Upon left side of neck, beneath the maxilla, is a marked swelling extending from below the left ear almost to the middle line. It is hard and almost " wood-like" in density. Only slight tenderness. Overlying skin a deep red and fixed over the mass. In centre of the mass is made out a small fluctuating area. Later this was incised and a small quantity of pus escaped. Repeated examinations of this pus showed threads. No granules or radiating threads found.

*Treatment.*—No further operation. Hot dressings daily. X-ray treatment every second day. Potassium iodide, beginning December 12, 1902, with grs. xv, t. i. d., increasing dose one grain daily till January 2, after which grs. l, t. i. d.

Temperature on entrance was 100° F.; pulse, 112; respirations, 24. Following incision, temperature, pulse, and respirations came down to normal. After December 23, 1902, became somewhat accelerated, and subsequently varied between 96 and 120. With light attack of tonsillitis, January 13, 1903, there was a rise of temperature to 103° F.

The area of induration gradually diminished in size and became softer, and at time of discharge from hospital, January 21, 1903, there was no longer any pus, and area had diminished to one-quarter the size at entrance.

One year later no trace of lesion remained.

Case IV.—F. R., aged fifty years; Spirit Lake, Iowa; farmer. Family history negative. Previous history negative. Denies venereal infection.

Present trouble: In June, 1903, patient had trouble in the rectum, which he supposed was due to piles, and in August underwent an operation. At this time the doctors told him that there were ulcers in the rectum. September, 1903, an abscess formed in front of anus, and was operated upon. There was some difficulty with urination. He passed pus from rectum from time of first operation, at one time quite a large amount. Sinus remaining after opening of abscess continued to discharge until time of entrance to hospital, November 3, 1903. Examination on entrance

showed body much emaciated. Perineum red and swollen. Two fistulæ in front of anus leading up towards the rectum. No. 20 sound passed in urethra. Urine negative. Temperature, 101° F.; pulse, 112; respirations, 28.

November 4. Operation. Sinuses incised upward towards rectum. Granulation tissue curetted. Wounds packed with iodoform gauze.

Discharged from hospital December 22, 1903.

Admitted to my service, May, 1904, with two fistulæ about rectum. General health bad; weak and emaciated. Diagnosis at this time tuberculosis. Fistulæ curetted and packed. No improvement followed the operation. Within a few weeks an inguinal bubo developed on the right side. This was opened, and in the pus the granules of ray fungus were seen. These were examined under the microscope, and the diagnosis confirmed. The patient was placed on iodide of potash and the X-ray. No improvement followed. The disease had evidently gained uncontrollable headway, and invaded first one hip-joint and then the other; then the sacrum and spinal column and spinal cord. Death from pneumonia.

Case V.—Young girl living in a suburb, with parents. Miss A. B., seen with Dr. Knight, of Waukegan, Ill. Nineteen years of age. Family history negative. Personal history negative, except for the following: In August, 1904, had an attack of abdominal pain; was confined to bed for several weeks. Diagnosis uncertain at first; later an abscess discharged through the vagina; about a pint of pus escaped. The mother of the patient stated that the pus was not ordinary yellow matter, but gray in appearance, and of the peculiar odor of decaying matter. The patient recovered from this attack, but never fully regained her health. About three days before I saw the case, in November, 1904, the patient was taken with an attack of pain in the abdomen and sharp fever, as high as 104° F. The probable diagnosis of appendicitis was made, and I was called upon to operate. Bimanual examination through rectum and abdominal wall showed a mass in the cul-de-sac of Douglas. Under ether this was opened through the vagina and drained. A peculiar bloody pus, with suspicious bodies, escaped. An examination of these bodies showed ray fungi. We had here probably an actinomycosis

of the appendix or cæcum, with perforation, to deal with. The young girl has improved greatly, and is now under iodide treatment.

CASE VI.—J. H.; captain of lake vessel; thirty-five years of age. Family history negative. Previous history negative.

Present trouble began more than two years ago, with an abscess in the region of the appendix. This was opened and drained. Patient never entirely recovered his health and strength. Complained of intestinal symptoms, and later an exploratory operation was made and the peritoneal cavity was found obliterated by adhesions, and the diagnosis of tuberculosis of the peritoneum was made. Later, two large fluctuating swellings appeared in the right lumbar region. When I saw him in consultation in the spring of 1904, these had opened, and were discharging a peculiar bloody pus, which, when examined, showed the macroscopic and microscopic evidence of actinomycosis. The patient was very weak; confined to his room. I advised iodide of potash and the X-ray. The latter was carried out by Dr. J. F. Smith, who informs me that the patient has made distinct improvement under the treatment. The region involved in this case is very extensive, and the prognosis therefore grave.

# CEREBRAL TUMOR.[1]

REPORT OF A CASE OF REMOVAL IN TWO STAGES BY THE OSTEOPLASTIC METHOD; SUBSEQUENT WIRING OF BONE-FLAP; INTRODUCTION OF A GOLD PLATE.

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A WOMAN, Miss A. K., aged thirty years, was admitted to St. Luke's Hospital, August 25, 1904. There had been a gradual failure of vision, the diminution being more rapid on the right side, until, at the date of admission to the hospital, she could barely distinguish light with the right eye, and could only make out shadows from large objects with the left.

Nearly five years before, a hard lump, an osteoma, the size of a walnut, appeared in the right parietal region. During three years it grew to the size of the fist, and it was of this size at the time of removal by Dr. J. S. Reeve, of Appleton, Wis., about eighteen months before admission. She had been troubled more or less with sick headaches since childhood, chiefly frontal and lately occipital, and also in the former period she had rheumatism, scarlet fever, measles, and diphtheria.

In addition to the dimness of vision and headache, Miss K. has noticed failing memory; numbness, with tingling beginning in the fingers of the left hand and creeping up the arm, varying as to time, but usually lasting about half an hour; vertigo and vomiting frequent; tenderness over the scar. Her appetite and sleep were unusually satisfactory; weight, 105 pounds; no gain or loss; constipation; menstruation, which began at fourteen, regular; family history negative.

She went out with difficulty, and fell a number of times in consequence of defective vision and dizziness. During childhood the headaches were very severe. The vomiting sometimes lasted nearly half a day. The attacks occurred almost daily. She suffered in this way until August 24, 1904, although not so severely as in childhood.

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[1] Read before the Chicago Surgical Society, January 16, 1905.

*Physical Examination.*—(*a*) General. Color healthful; patient cheerful; well nourished; strength and development fair; right-hand grasp somewhat stronger than that of the left; papular eruption on chest, shoulder, and arms; shape and movements of chest normal; hallux varus on both sides.

Head. The skull is abnormally prominent at the site of the operation for the removal of the osteoma; vessels of the scalp largely dilated.

*Special Examination.*—(*b*) No deviation of tongue; pupils dilated; vision of left eye much impaired.

The following is the report of Dr. Paul Guilford's examination of the eyes:

"Tested together both pupils responded quickly and equally to light, but when left uncovered the right pupil dilated and did not respond to light. Vision of right eye was reduced to simple light perception; vision of left eye 20/50; not improved by glasses; media clear; marked choked disk of both eyes, especially of the right, where nerve had swollen eight diopters; left nerve swollen five diopters; no retinal hæmorrhage. Optic atrophy will surely follow; prognosis very bad." He did not think vision would be improved by removal of a tumor.

Touch and sensation were apparently normal; reflexes responded readily on the right side; knee, biceps and triceps reflexes exaggerated on left side; no Babinski; no ankle clonus.

The following diagnosis was arrived at: Intracranial tumor, probably an osteoma, growing from the inner surface of the skull beneath the site of that above referred to. Dr. Archibald Church saw the case in consultation, and concurred in the diagnosis of brain tumor in the location of the osteoma removed by Dr. Reeve. The operation was set for August 30, 1904.

*Technique.*—After a final table preparation of the head, the upper and lower extremities of the Rolandic fissure and the middle meningeal artery were located. A large horseshoe-shaped flap was outlined by incision in the parietal region on the right side, the base or pedicle looking downward, the flap being made narrower at the base for convenience of subsequent operative steps; scalp separated from the bone, leaving about one inch of bone surface exposed previous to making four small trephine openings in the skull, one on either side at the pedicle and one on either side of the upper portion of the flap, with a view of dividing the

intervening bone. The hæmorrhage from the scalp was profuse and difficult to manage. In spite of the fact that the head was encircled with an elastic band, hæmorrhage persisted even after a number of artery forceps had been employed. These, as well as digital compression here and there, were not sufficient to completely arrest the bleeding. In other words, the moment the pressure was relaxed the hæmorrhage was renewed.

The trephining was completed, and the intervening bone, between the two upper trephined holes, divided with considerable difficulty, as the bone was half an inch thick and devoid of diploic structure, so that the division of the skull by rongeur forceps was very tedious. At this stage the patient's condition became so alarming, chiefly from loss of blood, that it was thought best to abandon the operation for the time being. The wound was quickly closed by continuous suture. The prostration was extreme, and great difficulty was experienced in carrying the patient through the next twenty-four hours. She had, however, so far improved that the second stage of the operation was performed on September 6.

*Technique.*—A thorough table preparation; rubber constrictors placed around the head; scalp readily pulled apart at the line of incision. Bleeding immediately became very severe, but was quickly arrested by loosening the scalp at the pedicle for the purpose of enclosing the latter in an elastic ligature. The division of the bone-flap, by means of rongeur forceps, became very tedious and discouraging until, by means of a burr-head drill, the skull was thinned sufficiently to allow the biting forceps to proceed more rapidly.

The bone-flap at the pedicle was partially divided by means of the Gigli saw having been passed beneath, and the underlying parts protected by means of F. C. Schaefer's Protector. Moderate force completed the division by fracture, when the osteoplastic flap was readily turned down exposing the dura. There was an opening in the dura at the upper right-hand segment of the exposed portion, filled with a soft tumor-like substance. This opening was enlarged sufficiently to introduce two fingers, by means of which soft, light purple material was removed from a surrounding capsule. The tumor-like substance was of the consistency of shad roe. Several sutures were placed in the dura and the tumor cavity packed with iodoform gauze. No effort was

made to remove the capsule. The osteoplastic flap was replaced, iodoform gauze drains brought out at dependent portions of the incision, the scalp wound sutured, constrictor removed, and large dry-dressing applied. Patient was in fairly good condition upon her return to the ward, but two hours subsequently the pulse became very feeble, almost imperceptible, and her condition in general required close attention. The next day, however, there was marked improvement.

At the first dressing on the 8th there was a slight amount of purulent discharge at the lowest drain opening. September 20 all the stitches were removed. There were four points in the scalp from which there was a discharge, viz., at both lower segments of the flap, a point where the tumor was situated, and the middle of the posterior leg of the incision.

It was observed at the dressings that the osteoplastic flap was elevated one and one-half centimetres above its normal level. It was, however, easily pressed into position without resulting cerebral symptoms. A hernia cerebri had developed, but it was easily reduced, and it was thought that it could be made to disappear by means of compresses of iodoform gauze and other dressings kept in position by a strip of adhesive plaster, and over all a Martin's bandage, the latter being more particularly directed to keeping the bone-flap in position. Peroxide was directed to be used through the drainage openings beneath the scalp, followed by irrigation with normal salt solution.

We found that the elastic bandage was not borne well,—not that it produced brain symptoms, but the pressure around the jaws was distressing, and it became necessary to discontinue it.

September 26 the discharge had diminished. As there was no tendency towards bone union in the skull, and without such pressure, as the patient was unable to endure, it was impossible to prevent the reappearance of the hernia cerebri and the further elevation of the bone.

September 26 the following final operation was performed: Drilling the skull; insertion of a 22-carat thin gold plate beneath the edges of the bone and over the cerebral protrusion; silver wire introduced; flap pressed into as close apposition as possible and wire twisted; edges of scalp wound freshened with scissors; scalp sutured; dry-dressing with gauze drain.

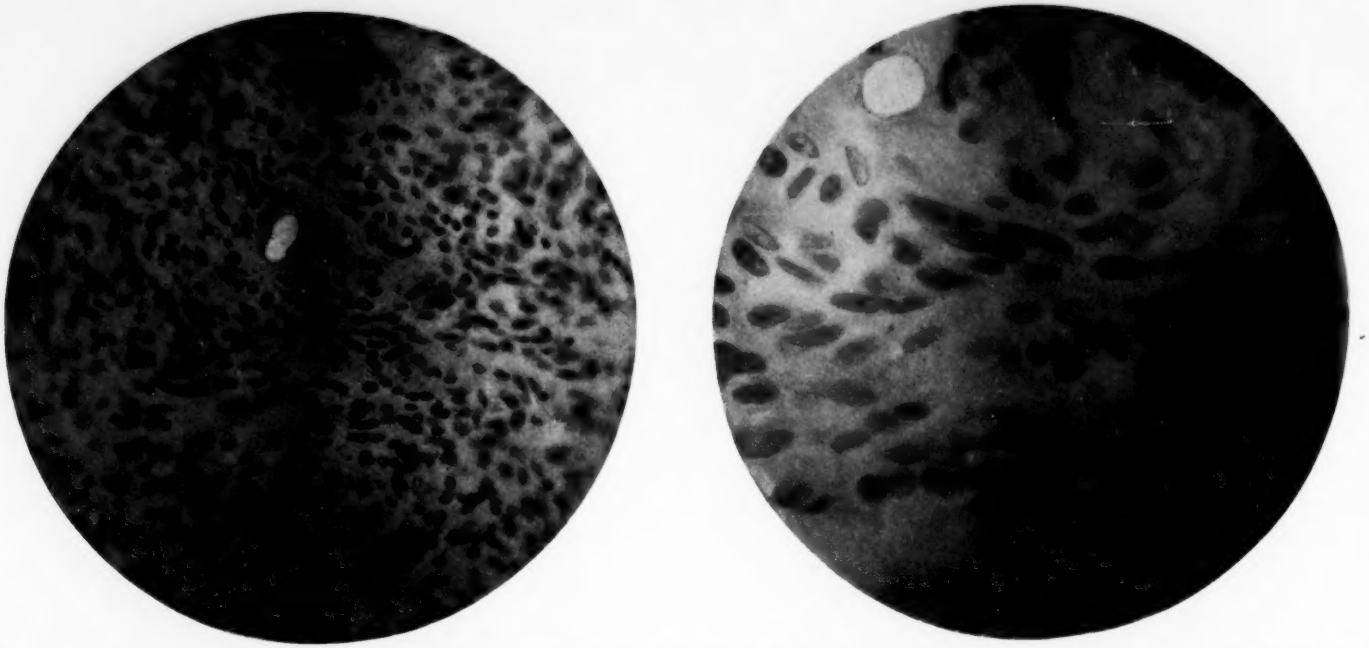

FIG. 1, under low power, shows very well the general structure of the tumor; while FIG 2, under high magnification, shows the spindle formation of the tumor cells where they are cut longitudinally. (Dagg.)

October 1 there was some transient numbness in the left hand.

October 4, interne in charge, while using peroxide along the scalp, accidentally forced some beneath the skull. Immediately the patient complained of numbness in the entire left side of tongue, with severe pain in the head. The numbness disappeared in a few hours, but the headache lasted over a day.

The tumor proved to be a round-cell, capsulated sarcoma. It spread out over the dura for a short distance, some sharp fibres from the skull running into it. The skull was hypertrophied and the diploic space obliterated. The operation was negative, as was predicted, so far as vision was concerned.

Patient stated that objects were recognized with the left eye as she formerly saw them on a very dark night, but that she could not distinguish night from day.

"The histological structure of the tumor is that of a small spindle-cell sarcoma (Figs. 1 and 2), with a considerable amount of intercellular substance. The tumor cells seem to be arranged more or less into bundles interwoven in different directions, thereby giving a variety of form to the nucleus, depending upon whether the bundles were cut transversely, obliquely, or longitudinally. There are no giant cells to be found. Fine trabeculæ of connective tissue, which is very vascular, extend into the tumor from the periphery, and the vessel walls in this connective tissue are very well formed. But those in the tumor proper have very thin walls or none at all, in some cases showing an endothelial lining with the sarcoma cells in close contact; in others only a blood-space in which not even the endothelial coat can be made out." (Dagg.)

September 23. Pathological report of a fragment of the cerebral protrusion: "Fibrinous exudate unorganized; leucocytic infiltration; infection,—diplococci."

For the first operation, August 30, chloroform was employed, and later ether was substituted; for the second, chloroform; morphine, one-quarter of a grain, given hypodermically just before the administration of the anæsthetic.

The patient left the hospital on November 4. Nausea, vomiting, headache, and dizziness had disappeared.

On December 6, 1904, Dr. Reeve wrote me as follows:

"I am glad to tell you that the patient seems to be doing

well. Silver wire was removed without difficulty two weeks ago. There is a small bit of bare bone visible at present. This is disappearing, and the wound requires dressing only every four or five days. Vision not changed; arm and leg are no worse; condition excellent;- no temperature or œdema; appetite good; patient looks well; no portion of the gold plate is visible."

I have received two letters from the patient, the last one written December 10, 1904. She stated that the head did not pain, but sometimes there was a momentary throbbing. She further informed me that her appetite was good and she slept very well. The arm and leg had not troubled her since the headaches and vomiting ceased. There was no change in the vision, but artificial light was somewhat annoying.

# RETROSTERNAL ACCESSORY THYROID TUMOR.

REPORT OF A CASE REQUIRING REMOVAL, TERMINATING FATALLY.

BY HOWARD D. COLLINS, M.D.,

OF NEW YORK,

Assistant Surgeon to the City Hospital.

THE anatomical range in which it is possible to encounter an accessory thyroid gland is large, extending from the base of the tongue to the arch of the aorta in a vertical direction, with the great vessels of the neck forming the lateral boundaries; posteriorly the area is limited by the spinal column, while in front the glands may lie subcutaneously. They have also been found within the trachea and larynx.

In size the accessory glands may vary from a tiny nodule to a structure as large or larger than the typical thyroid. The shape usually depends on the yielding of the surrounding tissues during the development of the gland.

Accessory thyroids have been divided anatomically into *true* and *false*. The latter are merely outbuddings of the parent typical thyroid and remain attached to it by a pedicle of true thyroid tissue. The variety designated as *true* accessory thyroids is further subdivided into *attached* and *free*. The *free* are, as the name implies, perfectly distinct islands of thyroid tissue as opposed to the *attached*, where a strand of connective tissue binds the accessory structure to the typical thyroid body.

Accessory thyroids, both *true* and *false*, may be multiple or single. When present, accessory thyroids are subject to about the same pathological changes and in about the same proportion as the typical thyroid body,—a parenchymatous enlargement with colloid degeneration being the most common. Where the accessory thyroids are situated superficially and the structure is sufficiently large to admit of palpation, their presence may be appreciated, although, unless pathological changes occur, there are, as a rule, no symptoms. If

the bodies be placed behind the sternum or masked by the larger structures of the neck, both the subject and the surgeon are probably in ignorance of the presence of any abnormal structure. Enlargement with pressure on the surrounding structures are usually the first signs to arouse our suspicions. The pressure symptoms vary, of course, with the structures pressed upon, and these depend on the site occupied by the tumor.

Concluding the above brief review of the subject, the writer offers the history of the following case that came under his observation.

Mrs. A., aged forty-seven years, mother of one child, presented herself to the writer on December 1, 1902. She had a globular cystic tumor about one inch in diameter to the right, but close to the median line of the neck, overlying the thyroid cartilage. Unquestionably, a cyst of the right lobe of the typical thyroid gland. The tumor had been present for nineteen years, although at first quite small; in the last two or three years there had been a decided increase in size, and lately there had been some difficulty in breathing, which the patient properly attributed to pressure on the trachea. There was no difficulty in swallowing or evidence of nerve pressure. Since girlhood the patient had been subject to bronchitis, not a winter passing in the last thirty years without a severe attack. In other respects her history and examination were negative. Operation was decided upon and performed the following day, December 2, 1902.

Under general anæsthesia, a median two-inch vertical incision was made, with parting of the muscles down to the thyroid. The substance of the gland was divided over the eminence of the tumor and the cyst pealed out of the gland tissue. Instead of finding a simple spherical mass, the globular head of the cyst had a tail or backward prolongation about a half-inch in diameter, extending along the right side of the trachea and œsophagus until only a thin layer of gland substance lay between the termination of the cyst and the muscles covering the front of the cervical vertebræ. Two small cysts about a quarter of an inch in diameter were shelled out from the left lobe of the gland. All bleeding points were then tied, the ligatures being left long; the latter

were then tied tight to one another, thus largely diminishing the size of the cavity without running the risk of renewed hæmorrhage from needle puncture in attempting to diminish the cavity with sutures. A straight tract about one-quarter of an inch in diameter was thus left extending from the partially sutured skin nearly to the vertebral column; into this a rubber-covered gauze drain was placed. It was noted at the time of operation that the trachea at its upper end had been slightly dented on its right side by the cyst. Examination of all three cysts showed the usual colloid material.

The second day after operation the patient had the symptoms of a severe attack of bronchitis, with much coughing and secretion. The wound looked healthy; there had been but little hæmorrhage. The drain was removed and a fresh one introduced only part way to the bottom. On the fourth day the wound was again dressed; superficial wound infection evident, and a removal of the drain was followed by some mucopurulent tenacious discharge, not the usual pus of wound infection, but more like pus mixed with colloid material. After thorough cleansing, a rubber tube was placed in the wound cavity, extending to the posterior limit. Rubber-tube drainage was used instead of gauze, as the trachea seemed to have a tendency to constrict the tract, leaving an enlarged portion posteriorly.

At the end of three weeks, the bronchitis having disappeared and the sinus practically free from all active inflammation, the patient went to her home in the country and passed out of the writer's care.

On December 7, 1903, one year later, she again presented herself to the narrator with the following story. After leaving New York, it had been almost impossible to keep the rubber drainage-tube *in situ*. The tube would remain in place but a few hours, and a day or two would elapse before she presented herself to her medical adviser. A reintroduction of the tube was followed by a copious discharge of pus, and the cycle would be repeated. After a time she gave up all treatment. The sinus persisted, the discharge would be very scanty for several days, during which time she would feel ill, then a free escape of pus would occur, and she felt better for a day or two. She had lost much strength and was thin and anæmic.

On examination, the local condition showed a sinus orifice

in median line one inch above episternal notch. Although this was the mouth of the old sinus, it had unquestionably been drawn downward, its change of position and the folds of skin attesting to that fact. At first a probe could be introduced only about a half-inch, but by careful exploration it was possible to map out a sinus extending backward about an inch and a half, and then taking a downward curve for about another inch, terminating in an enlarged cavity. In this cavity lay a hard substance distinctly clicking against the probe. A skiagraph was made with the full expectation of showing a small safety-pin pictured in the cavity. The skiagraph showed nothing, although the control pin placed on the surface of the neck distal from the plate was clearly portrayed. The sinus was gradually dilated with increasing sizes of rubber tubing, until a pair of specially curved forceps could be introduced, and by this means a spicule of bone-like substance about one-quarter of an inch long was withdrawn. At each subsequent examination similar pieces of material were removed, leading to the conclusion that the long-standing suppuration had resulted in a necrosis of a part of the body of a vertebra. An operation of exploration was suggested and accepted.

On March 9, 1904, under general anæsthesia, a three-inch median incision, circumventing the orifice of the sinus, was made, extending from the thyroid cartilage to the sternum. The sinus, previously distended with gauze, was then dissected out and traced backward. To the operator's surprise and mystification, the sinus, which originally had passed to the right of the trachea and œsophagus, now lay to the left of those organs. The sinus terminated in a slightly enlarged cavity lying on the vertebral column at about the level of the sternal notch. Below, and apparently a continuation of the termination of the sinus, lay a discrete mass, at first thought to be enlarged lymphatic ganglia, about three inches long in a vertical direction and about an inch and a half transversely, and the same anteroposteriorly. This mass lay just to the left of the median line, terminating below behind the arch of the aorta; the trachea and œsophagus were to the right, while the left recurrent laryngeal nerve and left common carotid had been markedly displaced to the left.

The entire mass was completely and with comparative ease shelled out from the cellular tissue without any bleeding of moment. The upper part of the wound was retracted to permit

an inspection of the thyroid body and the field of the former operation. The isthmus and lower margins of both lobes of the thyroid were seen and proved to be in no way connected with the mass removed. The site of the original cyst was a small scar.

The wound was then closed except at the lower part, where a large rubber-covered wick was placed to the bottom of the cavity in the cellular tissue behind the arch of the aorta. The pulsations of the aorta were most markedly transmitted to the packing, the external end swaying with each beat. The usual sterile dressings finished the operation.

On gross section the mass was clearly pure thyroid tissue with many colloid cysts and numerous calcareous deposits, the sinus evidently terminating in one of the cysts that had ruptured.

Microscopically the report confirmed the gross examination. The microscopic report with the anatomical observations made during the operation place the tumor in the class of *true* retrosternal accessory thyroids. Of these tumors the writer finds only three reported (Wagner (von Bergmann)) that have undergone the pathological changes noted above, *i.e.*, colloid degeneration with calcareous deposits.

For three days after the operation the patient gave every hope of a prompt recovery. The shock was slight; there was no impairment of voice or deglutition. Temperature not above 100° F. The wound was aseptic, and the large cavity diminishing rapidly by the gradual return of the structures to their normal position.

On the fourth day, however, a lobar pneumonia of the right middle lobe developed, rapidly spread to the adjacent lobes, involving the entire right lung, and eight days after operation the patient died.

The writer offers this report for publication because he believes that diseased accessory thyroids demanding surgical interference are not common, and furthermore the area involved in the surgical interference in this case is one not often invaded. At the primary operation the tract of the cyst passed unquestionably to the right of the trachea and œsophagus, at the second operation the sinus lay equally clearly to the left of those structures. The writer's explanation and belief as to

this fact is that, during the slow healing at the deeper parts of the original sinus, a cyst of the accessory thyroid increased in size, passed across the trachea from the left side, and finally ruptured into the sinus. Thus, while the superficial part of the old sinus served as an outlet for both tracts, the deeper parts of the original tract healed, and the more recent channel remained open. So large an exposure of the mediastinum must predispose to pneumonia, yet, had the patient not had so marked a tendency to pulmonic disease, it would not have been unreasonable to have expected a successful outcome.

# TRANSTHORACIC RESECTION OF THE LOWER END OF THE ŒSOPHAGUS IN A DOG.[1]

UNDER NEGATIVE AIR-PRESSURE IN SAUERBRUCH'S BOX; A PERSONAL EXPERIENCE.

BY WILLY MEYER, M.D.,

OF NEW YORK,

Professor of Surgery at the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the German Hospital; Consulting Surgeon to the New York Skin and Cancer Hospital and to the New York Infirmary.

LAST summer, when visiting the University of Breslau, on a flying trip to a number of German universities, I had the pleasure of witnessing a resection of the œsophagus just above the cardia, done by Dr. Sauerbruch, one of the assistants of Professor von Mikulicz, in the well-known box constructed by him.

I had read with intense interest, in the early part of the year, the publications by the Breslau Clinic regarding intrathoracic operations under negative air-pressure, as well as those emanating from Heidelberg, favoring the performance of such operations under increased air-pressure, without the aid of the pneumatic box, or cabinet, which to-day, in the scientific world, bears the name of its author, F. Sauerbruch.

I crossed the ocean with the intention of making a thorough study of Sauerbruch's method at the place of its conception, and the pleasure that I derived therefrom is mingled with but one regret, namely, that the time at my disposal was so extremely limited.

Before describing the particular operation, which forms the title of this paper, I should like to make a few general remarks regarding the origin and plan of the method.

In an original communication published by Dr. Sauerbruch in No. 6 of the *Centralbl. für Chirurgie*, 1904, February 13, entitled, "On the Ways and Means of excluding the Injurious Effect of Pneumothorax in Intrathoracic Operations,"

[1] Read before the New York Surgical Society, December 14, 1904.

he stated that in October, 1903, he had been charged by his chief, Professor von Mikulicz, to investigate the question as to how best to prevent the occurrence of a pneumothorax in intrathoracic surgery, the main point to be considered being to render practicable transpleural resections of the œsophagus for carcinoma, a procedure which, so far, had been followed by the most disastrous results in experiments upon animals as well as in the human subject.

The inevitable occurrence of pneumothorax upon opening the thoracic cavity being the chief obstacle to our working within the same with equal freedom as we do within the abdominal cavity, the direction in which the theoretical solution of the problem lay, was clear. It was evident that such operations would have to be done either by increasing the pressure within the lungs, exposing at the same time the thoracic cavity to ordinary atmospheric pressure, or by reversing conditions, that is to say, placing the thoracic cavity under decreased or negative pressure, while the bronchial system remains exposed to normal atmospheric pressure. Whether or not this could be practically carried out, of course, could be determined by experimental research only.

The method, long employed by physiologists, of rhythmically pumping air into the lungs through a tube tied into the trachea, the only method of operating under increased pressure known up to that time, had been tried by von Mikulicz, but his experiments upon animals had not been satisfactory. He therefore resolved to try the other alternative, the ways and means of which he left to Sauerbruch to discover. Von Mikulicz's charge to Sauerbruch, therefore, was to try and find a way by which it would be possible to open the thorax with the atmospheric pressure reduced, yet enabling the surgeon to do his work.

With this object in view, Sauerbruch set to work.

He first constructed a rather primitive apparatus, consisting of a glass cylinder closed at either end by means of guttapercha paper; the latter contained three openings (one larger and two smaller ones) on one side and a larger hole on the

other (Fig. 1).* Through the two larger opposite holes the animal was pulled so that the head rested outside of the cylinder at one end, the hind legs and abdomen at the other, the trunk remaining within the cylinder. The necessary instruments having been placed within, Sauerbruch pushed his hands through the two smaller openings at the head end. After this all holes were closed air-tight, and air was withdrawn from

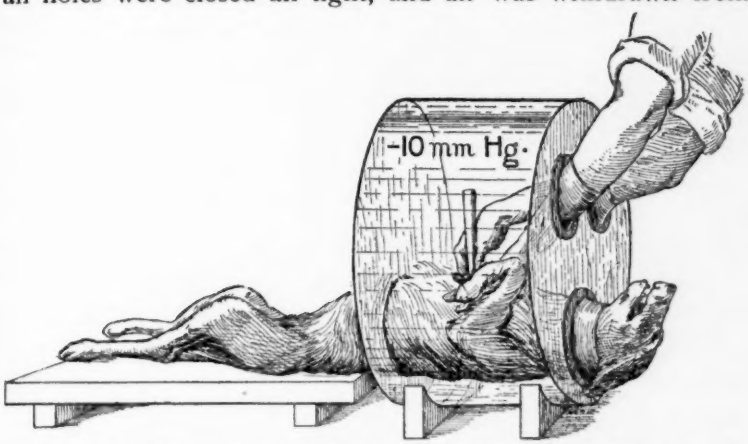


FIG. 1.—Sauerbruch's original primitive apparatus, which was constructed for the sake of finding out whether the thoracic cavity of a dog could be opened bilaterally with impunity by atmospheric air-pressure being reduced.

within (by suction) through a drainage-tube, until the pressure was reduced to the desired degree. Then the thorax of the animal was opened bilaterally. The lungs did not collapse and respiration continued undisturbed. Three minutes later a rent in one of the membranous end coverings of the cylinder occurred, with the result that the lungs collapsed under the atmospheric pressure and the animal died almost instantly.

Encouraged by this experiment, Sauerbruch had another improved box constructed (Fig. 2). This was about five feet long, a little over three feet wide, and about four feet high. It was made of wood three-fourths of an inch thick, tin-lined, and covered with a glass roof. The door was not quite four feet high and two feet wide, and was hermetically closed by

* The figures have been copied from Sauerbruch's and Brauer's articles repeatedly referred to.

means of rubber straps. In the wall opposite the door was a hole about one and three-fourths feet in diameter, which was closed by a rubber cap with a central opening, through which the head of the animal was pushed; a rubber cuff was placed around the well-shaven neck in such a way as to avoid all ingress and egress of air. The box was large enough to hold an operating-table on which the trunk of the animal was placed,

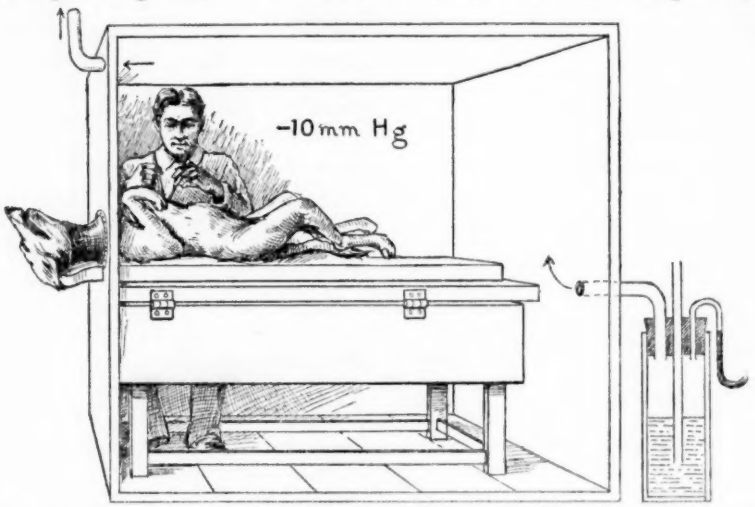


FIG. 2.—Sauerbruch's first wooden box, designed for intrathoracic operative work under negative air-pressure.

and besides furnished seating capacity on either side of the table for operator and assistant. In the upper corner of the wall which had the large opening was a smaller one, about the size of a silver quarter, which was connected with a suction-pump. In the opposite wall was one of the same size, constructed with a valve allowing the access of just sufficient fresh air to produce within the box the desired degree of under-pressure. Once in every four minutes the entire air within the box was changed. Ten millimetres Hg (mercury) proved the amount of negative pressure best adapted for these operations. Two persons could well work in the box for two hours without interruption and without appreciable personal inconvenience. Of course, the temperature within always rose by several degrees, from about 68° to 73° or 74° F., and the

percentage of humidity also increased, drawbacks which were soon overcome, in part at least, by the construction of a larger box for operations on the human subject. Among the operations done in above described box were resections of the œsophagus and of the lungs, opening of the pericardium and mediastinum. The glass top, besides admitting the light, gave a welcome chance to a number of spectators to witness the interesting work done within.

How far intrathoracic operations can be carried out in this way without immediately jeopardizing the life of the animal, is well illustrated by the following operations done on a chloroformized dog:

First, a large, bilateral flap resection of the thorax was done; then œsophagotomy added, and the pericardium with mediastinum opened. After closure of the wounds, the animal came to and was able to run about the room. As the operation had to be done without aseptic precautions and suture of ribs, death ensued on the second day. At the autopsy both lungs collapsed when the pleural cavities were opened, same as we are wont to see happen under normal conditions, and without showing any atelectatic portions.

The cardinal question of the feasibility of such operations under negative pressure having been demonstrated, a larger room, one with fourteen cubic metres of air space as against two in the old box, was built at the Breslau Clinic (Fig. 3). It was arranged for operations under increased as well as negative pressure. It would lead me too far to give a detailed description of it here, but those interested I would refer to Sauerbruch's extensive article in *Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie*, Vol. xiii, Tome 3, entitled, "Zur Pathologie des offenen Pneumothorax und die Grundlage meines Verfahrens zu seiner Ausschaltung."

It was in this larger box that I had the privilege, in July last, to see Dr. Sauerbruch himself, assisted by Dr. Gottstein for many years assistant to the Clinic), do an operation which hitherto had been merely a surgical dream. Five persons were in the room, which was brilliantly illuminated by a large arc-

lamp and a number of smaller electric lights, namely, the operator and his assistant, one person to hand him the instruments, another to communicate with the outside, if required, by means of a telephone, and do such minor detail work as might become necessary during the operation, and myself. The narcotizer, of course, remained outside, but was able, in spite of double windows and the noise produced by the air-pump, to

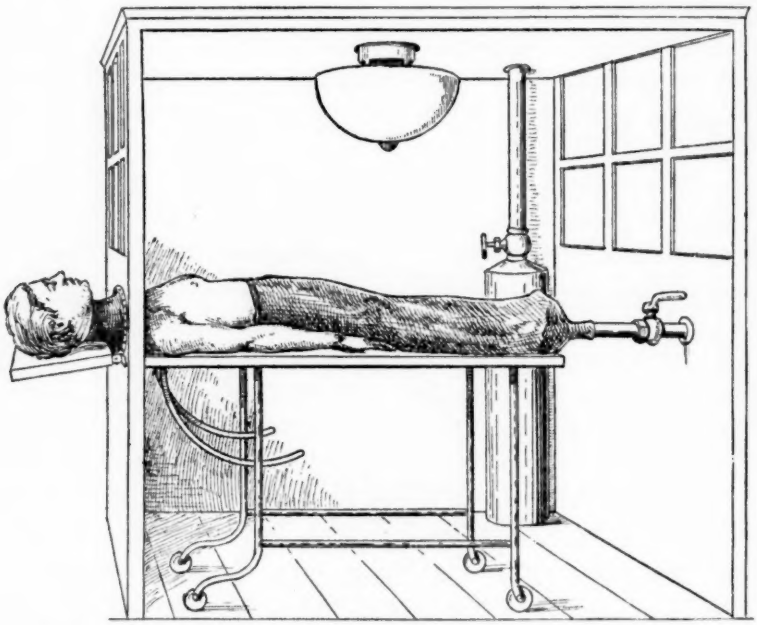

FIG. 3.—The chamber which is used at present for operations under negative air-pressure at the Breslau Clinic.* (A rubber sac, covered by canvas, surrounds the lower half of the patient's body. It connects with the outside by means of a straight tube. Thus the entire body of the patient, with the exception of the thorax and upper extremities, remains under ordinary atmospheric pressure. This arrangement maintains the normal pressure difference between the veins and the right atrium, and prevents stasis of the blood.)

hear the instructions called out by the operator. A number of interested assistants and other physicians stood outside watching the procedure. It was the hottest day of one of the hottest summers experienced in Germany within the last twenty years, and, while perspiration flowed freely, we all felt quite comfortable in this comparatively small room.

* Two more instructive illustrations, showing the details of the interior of the chamber, will be found in Sauerbruch's article.

A fair-sized dog, whose chest had been well shaved, was placed upon a pillow on the operating-table with the left side of his body thus pushed forward. The head and neck of the animal were outside of the box, a rubber cuff being fitted around his neck rather loosely, as it had been found unnecessary, in the course of experiments, to completely shut off the air at this point, the pressure controlling apparatus regulating matters perfectly, even if some air should enter at the head-hole; in fact, what little air could enter in this way had proven useful in helping to ventilate the cabinet. Then the operation was begun under due aseptic precautions. Longitudinal incision, about twelve centimetres long, in the fifth intercostal space, the various tissues being divided parallel to the ribs and the costal pleura cut down upon. No collapse of the lungs; the dog continued to breathe normally. The lung which appeared to be in the way was quickly pushed aside and the œsophagus attacked; it was grasped with the left thumb and forefinger and pulled forward. The nervus vagus on either side was pushed back with forceps; they do not appear again during the operation. The foramen œsophageum of the diaphragm is entered into with the finger and bluntly torn, sufficiently far, to permit of pulling the cardia and adjoining parts of the stomach into the thorax. All this is easily and quickly done under full view of the spectators. Although both pleural cavities had now been opened and were widely gaping, breathing continued undisturbed as before. Aseptic gauze tamponade to all sides. The œsophagus, after being clamped above and below the division line, is cut half-way around only, in order to enable the operator to first catch the mucous membrane with small forceps, as it has a great tendency to retract. After this, total division. Then threefold purse-string suture with silk,* one above the other, the wall of the stomach being deeply grasped; inversion of cardia (supposed to be the seat of carcinoma) into the stomach, in this way shutting it off from circulation. This manœuvre is assisted by two forceps pushing the cardia inward. A few additional interrupted sutures secure the inversion. Thus the portion of the œsophagus near the cardia, being the seat of a carcinoma, is not cut out, but left in place, and shut off from circulation by inversion into the gastric cavity. Such an inverted

* Silk was used throughout the operation.

portion of cardia, as Dr. Sauerbruch told me, had later at the autopsy often been found as a totally necrosed part within the stomach.

Then the posterior wall of the stomach was caught with two forceps, put on the stretch, and stitched to the posterior circumference of the œsophagus with interrupted silk sutures, same as is done in gastro-enterostomy with needle and thread. Thereupon the stomach was opened and united with the œsophagus by interrupted (silk) sutures, embracing the entire thickness of both organs. As much as possible of the anterior aspect is pulled to either side of the sutures in order to leave the smallest possible distance to close at the anterior circumference. Before this latter step had been accomplished, the animal vomited, flooding the operating field with stomach contents mixed with some blood. Fortunately, the greater part of this fluid was caught by the tampons. All having been carefully mopped away, the operation was again proceeded with. A few additional sutures were placed so as to pull the stomach over the œsophagus, and at last two stitches, one on either side, suspend the stomach in such a way that the original anastomosis is literally surrounded by the stomach wall. Finally, the wounds in the diaphragm and the peritoneum were closed around the œsophagus by stitching the same to the latter above the field of anastomosis without perforating the œsophagus, of course. In this way the entire place of anastomosis is buried within the peritoneal cavity. Irrigation with saline solution, generally employed by von Mikulicz at this stage of the operation, was omitted in this instance. Thereupon removal of the tampons and stitching of lower cut surface of the intercostal muscles to that of the upper one, including the superficial thoracic muscles, with interrupted sutures, about one-half inch apart, by which means the superficial muscles were partially inverted. Sufficient space remains between these sutures to see the lung beneath them. Then an increased working of the suction-pump was ordered, to produce greater negative pressure. This expands the lungs so that they lie close to the costal pleura again; now a second continuous muscular suture is put in, which hermetically seals the thoracic cavity. After this, fresh air is allowed to enter the box, and the skin wound is closed by a continuous suture and covered with iodoform collodion. The dog's pulse was good at the completion of the operation.

Through the courtesy of Dr. Sauerbruch I can add the following postoperative history of the dog operated upon: The animal did well during the first days following the operation. On the sixth day, dyspnœa, vomiting, rise of temperature set in, with dulness over the left pleural cavity. Diagnosis: empyema. Reopening of the wound gave exit to a large amount of pus. Drainage. The animal gradually recuperated. Four weeks later some stomach contents escaped out of a channel fourteen centimetres long, which latter, after two weeks, closed spontaneously.

It was evident, Sauerbruch states, that the suture did not close water-tight, a difficulty often met with in this kind of operations. The animal is still alive.

The appearance of an empyema in this case was no surprise to me. The mere fact that the animal vomited just before the completion of the anastomosis, thereby soiling the entire operating field, would seem sufficient to account for it. Besides, the occlusion was not perfect everywhere, a fistula discharging stomach contents became temporarily established.

It is interesting to note that the infection took place along the track of the operation, involving the pleural and not the peritoneal cavity. Of considerable additional interest to me was the following incident that occurred during the operation, which certainly was done with admirable skill and precision.

The supply of a certain size of silk had given out in the midst of the work, and had to be replenished without interfering with the physical conditions of the chamber. Here the wisely arranged anteroom, as shown in the accompanying illustration (Fig. 4), and described in Sauerbruch's exhaustive article referred to above, proved of invaluable utility. The attendant outside of the box was informed of the need, and promptly placed the desired silk into the anteroom, shutting the door, which fits airtight. Now the suction-pump included the anteroom in its sphere of action, after which the door between this compartment and the main room could be opened with immunity and the required silk obtained.

Surely, the arrangement of the chamber is most ingenious in every detail, being based upon careful experimental research as regards the required physical and physiological conditions.

And, in order that no mechanical accident may interfere with the operation, duplicates of all the parts of the outfit, from the engine down to the electric lights, are kept in readiness for instant substitution.*

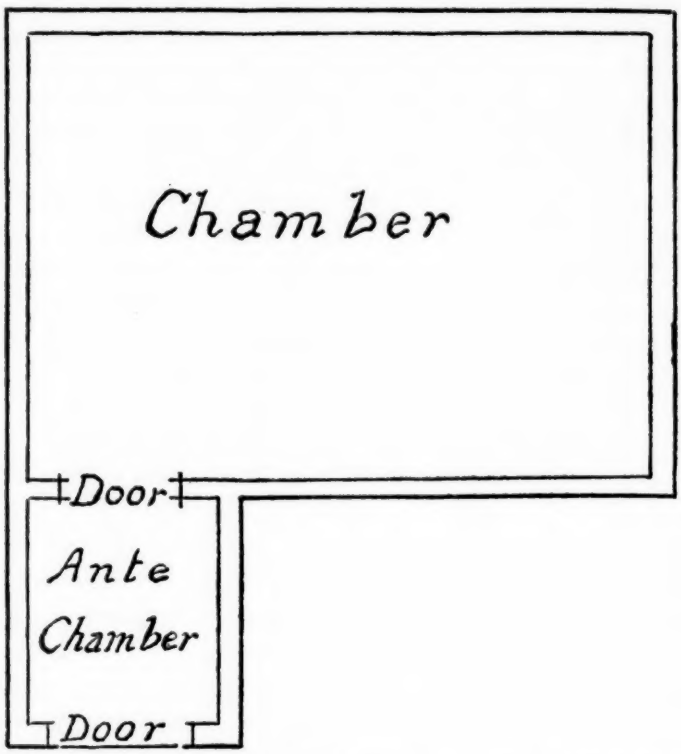


FIG. 4.—Showing the relation of chamber and antechamber. The latter can be put under negative pressure, too, and temporarily used as an additional room, if need be.

In his article "On Operations within the Thoracic Cavity with the Help of Sauerbruch's Box" (*Deutsche med. Wochen-*

* Dr. Wilms, of Leipzig, has shown a way of communicating between those within and those outside of the box without the use of an especially constructed anteroom (*Centralbl. für Chir.*, 1904, No. 8, p. 564). He also suggests a simplification in the construction of the Sauerbruch box, by making use of water to render the box air-tight. He would have the floor of the box separate and arranged with a gutter all around, filled with water, to receive the upper part of the box, the latter to be raised or lowered by pulleys. He further advocates the use of tin for the bottom and transparent celluloid plates for the upper part of the box.

*schr.*, April 14, 1904), Professor von Mikulicz, after referring to some of his experiments done within the same, and expressing his satisfaction at the easy access he has been able to gain to the œsophagus in his intercostal thoracotomies, points out the greater difficulties that exist in connection with œsophageal as compared to intestinal resections.

"The straight muscular tube," he says, "which we call 'œsophagus,' is but little stretchable; hence, even simple division and reuniting of the cut ends is not easily accomplished, as the œsophagus is slightly shortened thereby, and the consequent tension is apt to cause the divided ends to retract. In resections, of course, this difficulty is far greater."

Furthermore, the pleura, in most unwelcome contradistinction to the peritoneum, has little tendency to form rapid adhesions; and, hence, infection is often carried from without inward when draining the pleural cavity, no matter whether gauze, rubber drainage-tubes, or glass drains be used. As a result of such infection, empyema sets in.*

In view of all this, it is plain that the avoidance of a pneumothorax does not eliminate all obstacles in the way of our successfully operating upon the œsophagus.

Von Mikulicz classifies as distinct types resections of the upper and resections of the lower portion of the œsophagus; the latter offering much less difficulty than the former, for the reason that here the cardiac portion as well as the fundus of the stomach can be drawn up sufficiently to make up for the defect caused by the resection. This type of œsophageal resection is best carried out by an anterior intercostal thoracotomy in the fifth or sixth intercostal space.

According to von Mikulicz, the term "Thoracotomy" should comprise all incisions of the thoracic cavity, the same as laparotomy is understood to cover those of the abdomen.

For resections of the upper thoracic portion of the œsophagus, posterior thoracotomy in the third to fifth intercostal space

* For the purpose of reducing or eliminating the danger from infection during the after-treatment, von Mikulicz has constructed a small box, which is placed upon the wound so as to shut it off from all outside air.

has been found to give best results. The tube is here exposed right behind the hilus of the lungs. The vena azygos, which crosses the œsophagus at this place, is either pushed aside or doubly ligated and divided. Although it is feasible to sufficiently stretch the two ends of the resected œsophagus to perform anastomosis, the tension, as indicated above, would be so great as to make it doubtful that the sutures will hold. For this reason von Mikulicz no longer attempts to reunite the divided ends of the œsophagus after high resections, but instead has adopted the following procedure:

The distal end of the œsophagus is closed and dropped back. Then the wound in the thorax is carefully closed by layer sutures, and the proximal stump pulled out of an incision made along the lower end of the anterior border of the sternocleido muscle. This is easily accomplished because of the loose connective tissue around the œsophagus in the median line. The neck wound having been closed by sutures, this upper end of the œsophagus is then drawn underneath a bridge of skin and its end fixed in a small new incision above the second intercostal space, the step being similar to that employed in gastrostomy according to the Ssabanejew-Frank method. It is von Mikulicz's intention later to unite this opening with the gastric fistula by means of a special apparatus, thus making possible a way of feeding by mouth. A gastric fistula has, of course, to be established in all these cases. Unfortunately, the experiments for this purpose cannot be done upon dogs, as they do not stand feeding through a gastric fistula. But the descent of food into the stomach after such a procedure could be accomplished only by massaging the bridge of skin which substitutes the defect in the œsophagus.

No doubt it will be extremely interesting to watch future developments in this direction. Certainly, as von Mikulicz so eloquently points out in closing his article, these are highly interesting surgical problems of the future, in which our imagination is given almost unlimited scope.

To my mind, there does not seem to be any valid reason why the same good result that was obtained in the operation

upon the dog described above, should not be obtained in the human subject; and, if such an operation should prove successful in a case of cancer at or near the cardia, the prognosis would be rather good in view of the slight tendency of œsophageal carcinoma to form metastases.

So far, the few resections of the œsophagus done on the human subject within Sauerbruch's box at the Breslau Clinic (three in number) have resulted in the patients' death.

Since then Sauerbruch has not been idle.* He has perfected the technique in a conclusive way, at least in animals. In the *Centralblatt für Chirurgie*, January 28, 1905, he publishes his present method of operation. It certainly must be gratifying to American surgeons to know that the Murphy button has been the means of making these operations feasible and safe.

Sauerbruch distinguishes two methods:

1. Anastomosis between œsophagus and stomach;
2. Resection of the œsophagus.

These operations, it seems to me, may well be compared with our operations on the stomach done for carcinoma of the pylorus, viz.:

In inextirpable growths: on the stomach, gastro-enterostomy, on the œsophagus, œsophagogastrostomy; in excisable strictures, benign or malignant: on the stomach, resection of pylorus with closure of either end, plus gastro-enterostomy, on the œsophagus, œsophagogastrostomy, resection of the diseased portion and closure of either end.

1. *Anastomosing Œsophagus and Stomach.*—Having exposed the œsophagus as described above, under strictest aseptic precautions, the anatomical relations of the various parts surrounding and covering it are not disturbed in the least. The double serous covering of the cardiac portion of the œsophagus, viz., pleura and peritoneum, are incised at the foramen œsophageum; the abdominal cavity thus having been opened, the stomach is pulled into the thoracic cavity. Now, one-half

* This portion of the article, describing the recent evolution of Sauerbruch's technique, represents a later addition.

of Murphy's button is introduced from without, by the narcotizer, on an œsophageal sound grasped by the operator, his fingers resting on the outside of the tube and pressed against the anterior œsophageal wall; a short incision over the stem makes it appear. No purse-string suture. In cases of stricture of the cardia, the other half of the button is tied in the fundus of the stomach, and union effected by pushing the two halves together. The stomach is, of course, lifted up to the œsophagus. Careful suture with silk of the diaphragm to the portion of the stomach that has been pulled into the pleural cavity. It is of importance to see that no traction is produced on the stomach by the excursions of the diaphragm; if so, a greater portion of the stomach has to be transposed intrapleurally. Then the anastomosis, diaphragmatic sutures, and pleura are touched with Lugol's solution to induce rapid formation of adhesions; irrigation of the pleural cavity with saline solution and closure of the wound.

Thirteen dogs were thus operated upon and all recovered. Three died suddenly later. Autopsy in two of them showed that the stomach, much distended with fluids, had suddenly slipped into the pleura, compressing the heart. Careful suture will guard against this accident.

2. *Resection of the Œsophagus.*—Œsophagogastrostomy by means of the button, as before. Then, the nervi vagi are isolated two centimetres below the perfected anastomosis, the œsophagus compressed with an intestinal clamp and ligated with a strong silk thread; division. The same manœuvre at lower end of portion to be resected. Inversion of the latter into stomach by means of purse-string suture; stitching of stomach against upper stump in order to protect ligature (inversion here impossible). Closure of wound as above described.

Of eleven dogs operated upon in this way, every one recovered.

Besides these two typical operations, Sauerbruch has worked out a third procedure for resection of the cardia and the lowest portion of the œsophagus. He calls it the *inversion method*. It is done in two sittings.

*First Step.*—Thoracotomy; separation of diaphragm from œsophagus; isolation of nervi vagi, as before; then inversion of the lowest part of the œsophagus into stomach, the latter having been drawn up into the pleural cavity. Circular fixation of stomach to œsophagus by means of silk sutures. By this manœuvre a protrusion is made into the stomach not unlike the portio vaginalis uteri, consisting of the inverted cardia and the lowest end of the œsophagus. Suture of diaphragm to the wall of the displaced stomach, as before.

*Second Step.*—Fourteen days later: Laparotomy; pulling out of the stomach and opening same. Under guidance of the fore- and middle finger of the left hand introduced into the organ, the inverted portion of the œsophagus is cut off with Cooper's scissors. Hæmorrhage is slight; closure of wound in stomach and abdominal wall.

This operation, too, has proven signally successful in experiments upon animals. For practical purposes, it is, of course, indicated only in cases of small, clearly circumscribed tumors of the cardia, or lowest portion of the œsophagus. Sauerbruch calls it "the ideal procedure for resection of circumscribed, small tumors of the lowest end of the œsophagus or cardia." *

It is of importance to state that Sauerbruch has tried all these methods on the human cadaver, and found the anatomical relations exactly the same, so that he sees no reason why the successes that attended his operations upon the living dog should not be repeated in the human subject. No doubt we shall soon hear from the Breslau Clinic with regard to these operations performed on man.

What has been definitely shown thus far, however, is the great safety with which resections of the thorax can be done in the human subject under negative pressure obtained by means of Sauerbruch's box; and there can be no doubt that numerous other operations in which the pleural cavity is opened

* A fourth operation was devised by Sauerbruch for resection of the portion corresponding to the bifurcation of the trachea and of that above this place. It is also done at two sittings. The defect is closed by plastic operation.

with or without intent, as, for instance, those on the heart, for traumatic rupture of the diaphragm, for attacking a tuberculous affection of the vertebral bodies in Pott's disease, etc., may also be much more safely done within Sauerbruch's box.

The principal point in connection with intrathoracic operations at the present moment seems to be the question as to whether negative or increased air-pressure should be employed.

A few weeks after the publication of Dr. Sauerbruch's article, a short communication by Professor Brauer and Dr. Petersen, both of Heidelberg, appeared in the *Zeitschrift für Physiologische Chemie,* Vol. xli, Tome 4, and was soon followed by a more extensive *résumé* of the subject by the same authors, read at the Surgical Congress in Berlin. In it they pointed out the greater simplicity of the procedure, if done under increased instead of negative air-pressure, the employment of the latter always requiring an especially constructed box. They made the animal inhale oxygen from a tank, to which the vapors of the anæsthetic were added by a special arrangement of the bottles (Fig. 5).*

However, von Mikulicz had already carefully weighed the pro's and con's of the two methods, and Professor Brauer, in a later article (*Centralbl. für Chirurgie* No. 14, Beilage, April 9, 1904) acknowledges the priority of the Breslau Clinic in working out this question in all its various aspects.

Von Mikulicz states (*loc. cit.*) that, if increased pressure were shown to be equally as good as decreased or negative pressure, the technique for the production of the required pressure difference between bronchial tree and pleural surface could probably be greatly simplified. Among the possibilities considered by him are:

1. The use of a sort of a diver's helmet surrounding the neck in an air-tight way, the air entering and leaving the same under increased pressure, the narcotic being mixed with it.

2. A narcotizing mask closing mouth and nose air-tight, such as is used by dentists for nitrous oxide anæsthesia. Here, too, the narcotic would have to be mixed with the air.

* *Mitteilungen aus den Grenzgebieten,* Vol. xiii, Tome 3, page 483.

The danger in connection with these two devices would seem to lie in the possibility of the subject's vomiting.

3. Same as under 2, with the exception that tracheotomy is done, and respiration goes on through a tube fitting air-tight in the trachea.

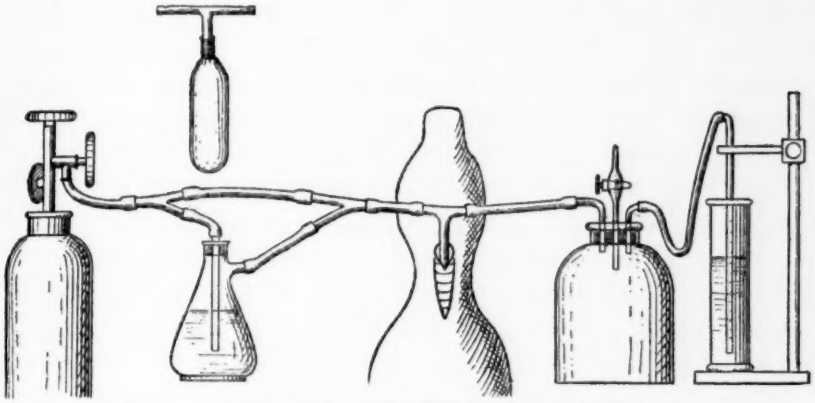

FIG. 5.—Apparatus for the administration of oxygen and chloroform.

Petersen and Brauer have successfully tried this latter method on animals,* employing an accurately working-pump and tank filled with oxygen, with which the narcotic was mixed (Fig. 5).

Sauerbruch's chamber, being arranged for increased as well as negative pressure, could, of course, also well be employed, although it would represent a more costly and complicated device than those above suggested.

Another method, still, has been recently proposed by Dr. F. Kuhn, of Cassel, Germany (*Centralbl. für Chirurgie,* 1904). This author has worked for some years on per-oral and per-nasal intubation, and has now evolved a method of pulmonal anæsthesia produced as follows: Nose and lips are tightly closed; a rubber tube is introduced into the trachea by intubation; at the level of the mouth, this tube passes through a wide

* It has been acknowledged by von Mikulicz that Brauer conceived the idea of using increased pressure for intrathoracic operations independently from and without knowledge of the experiments done at the Breslau Clinic. (*Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie,* Vol. xiii, Tome 3, p. 483, foot-note.)

rubber bandage which surrounds head and neck and, at the same time, holds the tube in position. In this way the lips are closed air-tight, clamps being added for greater safety, if deemed necessary. The nose is closed by compression. Chloroform and oxygen are used. Expiration takes place through Brauer's water-valve under pressure which can be regulated according to the need of the case (Fig. 5). In an article entitled, " No Pressure nor Vomiting during Anæsthesia" (*Berl. klinische Wochenschr.*, 1903, No. 17), he anticipates the objection which, naturally, at once arises in every surgeon's mind,—*i.e.*, what is to be done if the patient should vomit during such an anæsthesia with mouth and nostrils tightly shut, —by declaring that patients thus narcotized do not vomit.*

Personally, I do not think that the method of applying increased air-pressure after tracheotomy will ever find favor in operations on the œsophagus of the human subject, as it complicates matters very considerably. Just imagine a patient of fifty years or older undergoing resection of the œsophagus with a trachea wound and cannula in place. Would not the chances of contracting pneumonia during the after-treatment be greatly increased?

Furthermore, it must be remembered, with all these methods requiring the use of increased pressure, that if anything should happen to any of the apparatuses employed—except when using Sauerbruch's box for the purpose—death would instantly set in, and no amount of duplicate parts could be of any possible use.

This danger is excluded when operating under negative pressure in Sauerbruch's box, since here the defective part could be replaced (duplicates always being kept on hand) without deleterious effect to the subject.

The principle demonstrated by Sauerbruch's discovery is, that rhythmical, artificial charging of the lungs with air, corresponding to normal respiration—as has been long done by

* Since reading this article, another way of narcotizing under increased pressure has been described by Dr. H. G. Engelken, *Deutsche med. Wochenschrift*, 1904, No. 51.

physiologists—is not necessary to continue respiration with the thoracic cavity opened, but that spontaneous respiration goes on regularly and uninterruptedly, if a pressure difference is maintained between the air entering the bronchial tree and that to which the pleural cavity is exposed. This normal respiration goes on uninterruptedly, it may be added, even if the greater part of the thoracic wall is resected.

On the other hand, if the operation in question could be done as well and as safely on the whole, under increased air-pressure, this method would seem to deserve the preference from a clinical as well as financial stand-point. Operations under increased pressure would not have to be done in a closed box, but could be performed before a large audience the same as any other operation, and therefore would not necessitate the construction of a rather costly, special apparatus which here in America would hardly be procurable for less than from $3000 to $4000.

Of course, the great loss of animal heat would have to be considered, if these intrathoracic operations were done in our usual operating rooms.*

In a letter to me of November 3, 1904, Dr. Sauerbruch states that at a recent meeting of physiologists an overwhelming majority declared themselves in favor of negative pressure for intrathoracic operations, on the ground that here the physiological conditions remain undisturbed, while in the increased pressure methods the alveoli of the lungs are necessarily greatly distended. Sauerbruch adds that it will remain to be seen what *surgeons* think about the subject.

I feel sure that American surgeons will take part in this important research work, and do their share in solving the many interesting questions still awaiting decision.

* According to Sauerbruch's experiments, several degrees of heat are rapidly lost if animals (rabbits or dogs) with one thoracic cavity opened are exposed to the ordinary atmospheric temperature. This is due to the great blood-supply of the lungs and the exposure of the heart. With regard to operations, the effects of chloroform or ether—both reducing the bodily temperature—have to be considered as well as the loss of blood. In the box the loss of heat through the opened thoracic cavity is reduced to a minimum.

# GASTRO-ENTEROSTOMY AND PYLOROPLASTY.

AN EXPERIMENTAL STUDY BY MEANS OF THE RÖNTGEN RAYS.

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AND

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THE purposes of the operations most frequently performed on the stomach are relief from the distress and disturbed functioning that arise from pyloric obstruction, control of intragastric hæmorrhage, and removal of malignant pathological tissue, usually from the pyloric region. The two prominent methods for the relief of non-malignant pyloric obstruction are the surgical anastomosing of the intestine with the stomach at some point other than the pylorus,—gastro-enterostomy; and the artificial enlargement of the pyloric opening, —pyloroplasty. For the removal of growths in the pyloric region pylorectomy is the natural procedure, but with pylorectomy and the special treatment of gastric hæmorrhage this paper is not concerned. What is here presented is a discussion of gastro-enterostomy and pyloroplasty as surgical methods of obviating non-malignant pyloric stenosis. In this discussion evidence is brought forward from clinical sources, from recent physiological investigation, and from observations on animals on which gastro-enterostomy or pyloroplasty has been performed.

## THE TECHNIQUE OF THE OPERATIONS AND THE METHOD OF EXAMINATION.

The animals used were large cats, preferably females, since they are usually more quiet than males when fastened down for X-ray examination. The last feeding was at least

twelve hours before the operation. The animals were always completely etherized. The hair over the mid-abdomen just below the ensiform cartilage was clipped closely with scissors, but not shaved. This area was then washed with soap and water, scrubbed with a sponge of sterile absorbent cotton wet with ether, and occasionally with alcohol. The cat was then covered with a large square of sterile cotton cloth, with a slit over the site of operation. The instruments were boiled for five minutes. The sponges were bits of absorbent cotton, sterilized in mass, and torn into pieces of suitable size; a few sterile gauze strips were used. Suture material was either silk or linen thread, white or black; the threaded needles were immersed in alcohol without boiling. The operator's hands were prepared by scrubbing with a wood-pulp brush, common soap, and running water, followed by immersion in alcohol for two minutes. Gloves were not used.

Every effort was made to avoid unnecessary manipulation of the abdominal contents. The incision was invariably in the median line just below the sternum. The anastomoses were all made by continuous suture and without clamps, though in another series of cases clamps would be used at least in some of the operations. Before closing the wound, the omentum was always replaced in as nearly its normal position as possible. The peritoneum was usually closed separately, with catgut, and the fascia and skin together, either with catgut or silk. The dressing consisted of sterile cotton and collodion. The cats were given boiled water after eight hours, and gradually returned to their usual diet.

In spite of efforts to obtain an empty alimentary canal at the time of operation, food of some sort was usually present either in the stomach, the intestine, or both; and small worms (Ascarides) almost invariably emerged from the incisions in the intestine. Three cats died as a result of the operations; the others lived for months and grew fat. In the fatal cases death was due to obstruction from kinks at the distal end of the anastomosis, once from a twist in the mesentery, and in another case from beginning local gangrene of the gut in the

region of attachment. The gangrene was perhaps due to the fact that the incision in the intestine was made accidentally on one side and too near the mesenteric border, thus possibly interfering with the blood-supply of the gut. Neither in these cases, nor in any of the autopsies on the other cats, was there a sign of peritonitis. The junctions were invariably found tight, and the anastomoses patent. In one of the early experiments, when food was seen to leave the stomach always through the pylorus and never through the new opening, it was supposed that the anastomosis had in some way closed. The abdomen was opened, the gut opposite the site of the anastomosis incised, the aperture demonstrated to be patent, the gut returned, and the wound closed; then the food was observed as before to leave by the pylorus and not by the artificial way. The difficulty of forcing food to leave the stomach through a gastro-enterostomy opening, when the pylorus is patent, had not at that time impressed itself upon us as it did later.

In considering operations of this character, it must be remembered that the cat does not have a retroperitoneal duodenum; the only part of the small intestine of the cat which is not freely movable is at the end of the duodenum which is anchored by a rather delicate fold of mesentery; and the cat, walking upon all fours, and sleeping usually upon its side, presents conditions in regard to anterior and posterior gastro-enterostomy which are almost the reverse of those which obtain in man. For practical purposes, an anterior gastro-enterostomy in a cat corresponds to a posterior operation in man.

The gastro-enterostomy operation was varied by placing the anastomosis, or *stoma*, as we shall call it, at different points on the front and back of the stomach, by making the aperture large or small, and by uniting the gut with the stomach, so that gastric and intestinal peristaltic waves corresponded in direction, or were opposed. The two pyloroplastic operations employed were the Heinecke-Mikulicz operation[1] and that devised by Finney.[2] These two classes of surgical method will be considered in turn.

For purposes of observation, two varieties of food were fed the operated animals. Thin boiled starch (three or four grammes potato starch to 100 cubic centimetres water) was used to test the passage of fluid contents from the stomach. This food was introduced into the stomach by a rubber tube. Canned salmon was used as a more natural food to test the passage of a semisolid substance from the stomach. The salmon was always eaten voluntarily. Before the food was given, it was mixed with a small amount of subnitrate of bismuth, which rendered the mass opaque to the Röntgen rays. The course of the food in the alimentary canal could then be easily watched by means of a fluorescent screen.

With this method, the effects of the two classes of surgical procedure, gastro-enterostomy and pyloroplasty, on the passage of food from the stomach, were studied.

## GASTRO-ENTEROSTOMY.

The advantages said to arise from the performance of gastro-enterostomy are several. First of all, the new opening, if made at the most dependent part, is supposed to act as a drainage outlet for the gastric contents. This drain, in offering a new exit for the food, is thought to relieve the pressure on the pylorus and to decrease the amount of food going through the pyloric passage, or even to put that passage entirely out of function. With this new and easier way for the food to emerge from the stomach the work of the gastric musculature in forcing the food onward is diminished. And, finally, the shorter stay of the food in the stomach decreases the chances of fermentation and its attendant distress.

In the consideration of gastro-enterostomy which follows, the subject will be presented under five heads: drainage, the vicious circle, kinks, the disturbance of digestive processes, and the formation of jejunal ulcers.

Drainage.—In stating that the presence of an opening between the most dependent parts of the stomach and a loop of intestine "drains" the stomach, it is assumed that the stomach is a relatively passive bag, and that the food, which is swal-

lowed in a semisolid condition, somehow becomes liquid and runs into the intestine through the hole at the lowest point in this bag. There are a number of facts which should be taken into consideration before credence is given to the idea that the stomach is emptied by simple gravity drainage.

1. *The Stomach not a Passive Bag.*—First of all, the stomach is not at any time during digestion in the condition of a passive reservoir.[3] Within a few minutes after food is ingested peristaltic waves begin to pass over the pyloric half of the stomach, and these waves continue sweeping up to the pylorus so long as food remains in the stomach. The statement is repeatedly found in surgical literature that a gastro-enterostomy opening relieves the pylorus of the irritation from food and gastric juices. It seems to be assumed that a gastro-enterostomy midway in the stomach renders the region between the opening and the pylorus unnecessary for digestion and inactive. There is no reason for believing that peristalsis does not persist under these circumstances, and that the food is not thoroughly churned in the pyloric end by the peristaltic waves. No one should deceive himself by supposing that there is relief from the presence * of motor activity or acid secretions near the pylorus, after a gastro-enterostomy. We have seen the waves passing over the pyloric end of the stomach ceaselessly for long periods when the pyloric sphincter was externally ligated or completely closed by sutures. In short, then, the pyloric end of the stomach serves to mix the food with the digestive juices, to triturate the larger lumps of food, and, under normal conditions, to propel the chyme into the intestine whenever the pylorus opens and allows the chyme to pass.

The cardiac end of the stomach is the reservoir part of the organ. But this reservoir is not a passive reservoir. The muscle fibres extend in all directions over the cardiac end, and during digestion these muscles are in a state of tonic contrac-

* It is, of course, certain that gastro-enterostomy performed after pyloric obstruction shortens the duration of the presence of peristalsis and acid juices in the pyloric end of the stomach.

tion, pressing on the food within and forcing it into the churning process in the antrum as rapidly as it can be received.[4] Finally, as the food is pushed more and more into the intestine the stomach becomes gradually shorter. As might be expected from the prevalence of longitudinal muscles along the greater curvature, the shortening is more noticeable there than along the lesser curvature.

2. *As the Stomach empties, the Pylorus becomes the most Dependent Point.*—An important result of the shortening of the stomach as it empties is the change of position of the most dependent part. The greater curvature of the stomach in the cadaver or in a living person relaxed in anæsthesia commonly reaches a point considerably lower than the pylorus. But the shape and position of the stomach under such circumstances are not the same in the functioning organ. Observations with the Röntgen rays on the normal human stomach containing food mixed with bismuth subnitrate[5] prove that the shortening of the stomach takes place just as if the longitudinal and oblique fibres[6] passing over the surfaces to the greater curvature lifted the organ up towards the one fixed point of the contracting fibres,—the cardia. Since the pylorus is more or less fixed, it does not rise with the rest of the stomach. The consequence is that in the last stages of digestion, when the gastric contents are more fluid than in the earlier stages, the pylorus becomes the lowest point in the stomach,* and the contents therefore do not have to be moved upward in order to be passed out (Fig. 1).

Doubtless it may be argued that observations on a normal person do not hold good for abnormal conditions. It may be said that the attachment of the intestine to the stomach acts as a drag, keeping the stoma at the most dependent point, and that then the stomach must be merely a passive reservoir

* Bettman (*Philadelphia Monthly Medical Journal*, 1899, i, p. 133) has made post-mortem observations on the human stomach in a state of contraction after several days' fast. The pylorus is then the lowest point. He finds that as the stomach is slowly filled with water the greater curvature gradually becomes lower than the pylorus.

with its contents drained by gravity. Or it may be urged that when the stomach is dilated, toneless, and flabby, it cannot act normally, and the part observed to be lowest when the abdomen is opened must remain so. In answer to the first argument, that the point of union of stomach and intestine does not change position, the freedom and ease of movement of the intestinal coils may be cited as evidence against any firm fixation of the united parts in one place. If, however, the stomach is purposely attached to a *fixed* portion of the gut with the object of making the stoma permanently the most dependent point, it may be questioned, in the light of the evidence which is to follow, whether such a procedure, as a ready

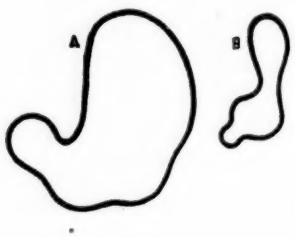


FIG. 1.—Tracings of the outlines of the gastric contents, made by means of the Röntgen rays, one hour (*A*), and four and three-fourths hours (*B*), after eating bread and milk mixed with bismuth subnitrate. Peristaltic waves are passing over the stomach. The line below the figures indicates the level of the umbilicus. The subject was a girl of seven years. The tracings are one-fourth original size.

means of clearing the stomach, is justifiable. In case the stomach is dilated and toneless the lowest point may remain the lowest point if there is no improvement in the condition of the stomach after the operation; but as the tonicity of the gastric musculature returns, the lowest point chosen by the surgeon is as little likely to remain the lowest point as is the case in the normal functioning organ.

Thus far, then, we may say that any point on the surface of the stomach, *not near the pylorus*, that is chosen as the lowest or most dependent point for purposes of "drainage" is in danger of being lifted, as the stomach shortens in emptying, until it occupies a position considerably above the part nor-

mally lowest towards the end of digestion, namely, the pylorus. This fact, coupled with the fact that so long as food remains in the stomach peristaltic waves move continuously towards the pylorus, argues strongly in favor of placing the stoma, not at what happens to be the most dependent point when the abdomen is opened, but near the pylorus, towards which the food is normally pushed and from which the food is most readily passed on into the intestines.

3. *Intra-abdominal Pressure Relations make Gravity Drainage impossible.*—The most important factor which must be considered in coming to a decision regarding the question of "drainage" is the factor of pressure relations within the abdominal cavity, and especially in the two parts of the stomach. The intra-abdominal pressure, *i.e.*, the pressure exerted on the outer surface of the stomach and intestines, is much less than is commonly supposed, for it varies only a few centimetres of water from the atmospheric pressure.[7] The pressure within the alimentary canal, when the canal is inactive, depends on the weight of the overlying organs. This fact was proved by Weisker [8] by measuring the pressure in stomach and rectum by means of manometers. He found that in dorsal decubitus the water in each manometer rose to the highest point of the abdominal cavity. In the upright position the water in the gastric manometer stood at the level of the xiphoid process; but in the head-down position, when the stomach was subjected to the pressure of the freely movable abdominal contents, the water in this manometer rose to the level of the anterior superior spine of the ilium. Similar changes of pressure can be observed in the inactive stomach as the subject lies either on the right or on the left side: on the right side the intragastric pressure varied between one and five centimetres water; on the left side, with the liver above the stomach, the pressure varied between thirteen and nineteen centimetres water.[9] Kelling has shown also that the intragastric pressure increases only slightly even with a large increase of contents, so rapid is the adaptation of the organ to different quantities.[10] The pressure inside the resting stomach and outside the stomach in the

abdominal cavity or in neighboring coils of intestine is approximately the same unless the body is resting on the left side or head downward.

The importance of the considerations in the foregoing paragraph lies in the bearing of these considerations on the question of drainage. The weight of the alimentary canal, as such, must be approximately that of water, which is approximately the weight of the swallowed food. The alimentary canal is not a rigid tube; its walls, unless contracting, are limp and flabby. The limpness and flaccidity of the walls cause the food contained within the canal to be pressed upon by a medium of about the same density as the food itself. To be sure, food pushed into a vertical loop held open by gas would fall by gravity through that loop, but such a condition is not to be regarded as at all usual. Under normal circumstances, therefore, with the walls of the canal in contact or closely surrounding the contents, gravity cannot act, and "drainage" in the common sense of that term is impossible.* In order that the food may be moved onward through the alimentary canal, muscular contraction is necessary to create a difference of pressure.

4. *Intragastric Pressure is greatest at the Pylorus.*—In the digesting stomach a difference of pressure would naturally be expected between the less active cardiac end, holding the food in a tonic grasp, and the more active pyloric end. As the pylorus is approached the pressure should be greater, for the peristaltic waves run downward in a series of several distinct constriction rings, and these rings, as they approach the

* Kelling (*Archiv für die Verdauungs-Krankheiten*, 1900, vi, pp. 455, 456) has also pointed out this fact. He writes: "The stomach is so well supported by the intestinal loops, which surround it, which adapt themselves to its form, and which have a specific gravity about that of water, that we may assume without essential error that it floats completely in water. Thus the labor of the stomach is relieved of the weight of the ingesta. . . . If we fill a gastro-enterostomized stomach with water, the water does not run out by itself, even with the patient in the upright position—because of the hydrostatic relations in the abdomen gravity can have no effect."

pylorus, squeeze deeper and deeper into the gastric contents. So great is the pressure under which the food is forced up to the pyloric sphincter that, when the sphincter does not relax, the food is squirted back through the advancing ring of peristalsis sometimes half the length of the antrum; and when the sphincter does relax the food is shot for some distance along the duodenum.[11] Actual measurement of the pressure in the cardiac and pyloric ends of the human stomach have been made. Von Pfungen[12] found in a boy with a gastric fistula eight centimetres to the left of the linea alba that the intragastric pressure near the fistula was upward from nineteen centimetres water, whereas directly in front of the pylorus the pressure was 162 centimetres water. Moritz has studied a normal individual, and, although his figures are lower than von Pfungen's, they show a similar difference between the two ends of the stomach. The average pressure in the cardiac end was six to eight centimetres water, while in the pyloric end there were rhythmic recurrences of pressure amounting in some cases to thirty-eight, forty, and even sixty centimetres water, though, as a rule, ranging from twenty to thirty centimetres.[13] The evidence is conclusive that the peristaltic waves sweeping towards the pylorus cause the pressure on the food in the antrum to be much greater than it is in the less active cardiac end.

5. *Food goes through the Pylorus rather than through the Open Stoma.*—The difference between the pressure at the pylorus and the pressure elsewhere in the stomach is important in its bearings on the discharge of food into the intestines. If there are two ways from the stomach to the intestines, the pylorus and the stoma, does the food pass out naturally by the pylorus, by both ways, or more readily by the stoma? Observations were made on ten cats on which gastro-enterostomy had been performed and the pylorus left untouched. In these cases the new aperture between the stomach and intestine was placed as follows: two in the anterior wall; one in the posterior wall, near the middle of the stomach; five in the anterior wall; one in the posterior wall, just before the narrowing of the

stomach that forms the antrum; and one in the posterior wall of the antrum. The stoma was varied in size: in two cases it was found at autopsy to be oval and about one and a half centimetres in length, in other cases it has two, two and a half, and even three centimetres in length.

When fluid boiled starch was given to the ten animals above enumerated, this fluid, instead of running through the stoma into the intestines, was forced out naturally by peristaltic waves, through the pylorus. Only two exceptions were observed, one in the animal with the stoma in the posterior wall of the antrum close to the pylorus, and the other in an animal with a large anterior stoma (three centimetres long) about half-way between the two ends of the stomach. The food left by both exits. But in the latter case canned salmon, less fluid, went out by the pylorus alone; it was not observed to pass through the stoma at any time during four and a half hours after feeding.

In one instance the pylorus was partly occluded. A tape was passed through the walls of the stomach in front of the pylorus, and tied; then the gastric wall was sewed tightly over the entrance and exit of the tape. The food still passed out by the pylorus. In another instance a linen ligature was tied snugly about the pyloric sphincter. A week later liquid boiled starch was fed, and, although peristaltic waves were continually sweeping up to the pylorus, the food was observed to pass out wholly by way of the stoma. Still later, when thick salmon was fed, the stomach was watched for the first three-quarters of an hour, and from two to two and a half hours after the feeding. No food was seen going from the stoma, but it was seen leaving in small amounts through the pylorus. At autopsy the ligature was found partially embedded, and the pyloric opening was about a third of a centimetre in diameter. These cases clearly show that even when the pylorus is narrowed so as to offer difficulty to the passage of the chyme, the chyme is forced through the natural way into the intestine rather than through an opening remote from the point of greatest pressure.

When salmon was fed, the food, with the one exception

above mentioned, was never observed to leave the stomach through the stoma if the pylorus was patent. The salmon, a more solid food than the starch paste, adds to the greater pressure in the pyloric region still another factor which causes the pyloric exit to be the easiest exit; this factor is the greater fluidity of the food in the pyloric end of the stomach. As long ago as 1834, Eberle noted that the food in the cardiac end of the stomach was relatively dry, while the contents of the pyloric end were mushy and fluid.[14] This observation is readily confirmed by examination of the stomach of a dog or cat after an hour or two of digestion. It is natural that a relatively fluid material under a general pressure should pass more readily from the stomach than a drier and more solid mass. For this reason alone the chyme should go out through the pylorus sooner than the unchymified food through an opening in the middle of the stomach. And when this difference of consistency, favorable to the pyloric passage, is combined with the greater pressure in the pyloric region, the reasonableness of the results observed in the cases above reported is manifest.

No difference was noted in the results from anastomoses on the front and from those on the back of the stomach. It may be that the operations were not sufficiently numerous to justify conclusions as to the relative merits of anterior and posterior anastomoses. But the evidence from the pressure relations in the abdominal cavity and in the stomach—the fact that the stomach is a muscular bag resting practically as if surrounded by water—indicates that the position of the stoma, anterior or posterior, has not the importance generally ascribed to it.

In the evidence presented in the foregoing paragraphs the physiology of the gastric movements has been considered with reference to its bearing on the emptying of the stomach after gastro-enterostomy operations. It has been made clear that peristalsis is seen only in the pyloric end of the stomach, that the pressure in the stomach is greater as the pylorus is approached, that the food in the pyloric end is much more fluid

than the food in the cardiac end, and that as a result of all these factors the food is more readily forced into the intestines through the pylorus than through the stoma, when these two exits are both offered. It should be observed that there is in these statements no slighting of the fact that improvements have resulted in clinical cases from gastro-enterostomy operations. The larger opening possible between stomach and intestine in the human subject may render the artificial passage-way relatively easier than it is in the small animals used for experiment; but the factors of peristalsis, pressure relations, and the difference of food consistency in the two ends of the stomach are as true for human beings as for these animals, and must make the pyloric passage in human beings an easier and more natural exit for the food than any artificial opening in other parts of the stomach. A justification of this conclusion is found in the experience of Mayo,[15] who observes that when gastro-enterostomy is performed with the pylorus unobstructed, the food seems to take its natural course and the operation is of little use.

THE "VICIOUS" CIRCLE.—In the animals on which gastro-enterostomy has been performed and the pylorus left unclosed or only partly occluded, a circulation of the food has been repeatedly observed. The food was forced through the pylorus, was pushed thence through the duodenum (never in the opposite direction), and entered the stomach again through the stoma. Animals have been watched a half-hour at a time, and over and over again at short intervals during this period food has entered the duodenum from the pylorus, and gone through the regular course, only to merge once more with the mass in the stomach. Usually at these times no food was observed to pass into the intestine beyond the stoma. It is of interest and of practical importance to note that the circulation of the food described above was seen especially when the stomach was stretched either by large amounts of food or by the application of pressure to the abdomen when moderate amounts of food had been given. The reason for this result is clear when the stomach wall in the region of the stoma is

stretched post-mortem. The stretching separates the edges of the opening to which the intestine is attached, and as the edges separate the intestine becomes drawn tight between them (Fig. 2). Thus the intestine forms a flat covering to the opening; it becomes, in short, practically a part of the gastric wall.* In the flattening of the intestine against the stomach, the opening into the intestine in either direction is merely a narrow slit, and these slits become still more narrowed to complete occlusion when pressure is applied to them from within

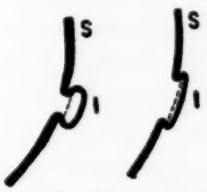


FIG. 2.—Diagram showing how stretching the stomach may cause the part of the intestine sewed to the stomach to become almost continuous with the gastric wall, and the openings into the intestine from the stomach to become mere slits. *S*, stomach; *I*, intestine.

the stomach. The effectiveness of these "valves" was tested in the excised stomach by tying the pylorus and filling the organ with water. As the gastric wall became stretched and the internal pressure increased, almost no water escaped through the stoma into the intestine. And when the cardia was closed and the stomach and its fluid contents further pressed by hand the "valves" were still more effective in preventing leakage.

Evidently the narrow slit-like openings into the intestine, which result from stretching the gastric wall, fully explain

* Kelling (*Archiv für klinische Chirurgie*, 1900, lxii, p. 35) thinks that the vicious circle is due to making too large a hole, so that when the stomach stretches the hole, a spur of the intestine is formed, projecting into the gastric cavity and preventing easy exit. But even with a small stoma, the contraction of the circular fibres of the intestine must cause the gut to lie flat between the lines of ligature and bring about the condition described in our experiments; and, furthermore, a small stoma from its smallness is less likely to be an effective exit. In this connection it is interesting to note that Moynihan strongly advocates a large opening, even four inches in length (*Journal of the American Medical Association*, 1904, xliii, p. 1971).

the prevalence of the circulation of the food from pylorus to duodenum and back to stomach again through the stoma, when large amounts of food are given. These narrow openings act like valves. The slit on the duodenal side of the stoma permits food which has passed the pylorus to return without hindrance to the stomach, but both slits offer a distinct obstacle to the forcing of food outward from the stomach into the intestine. The obvious moral that meals should be moderate in amount in gastro-enterostomy cases need only be mentioned.

The circulation of the food described in this section has never resulted in the clinical symptoms of a "vicious" circulation. The animals have never vomited as a consequence of the repeated passage of the food from the duodenum into the stomach. Indeed, the recent observations of Boldireff [16] render it probable that in the stomach a certain amount of bile and pancreatic juice may be found quite normally. Kaiser [17] cites numerous observers who found after gastro-enterostomy in human beings that bile was almost invariably present in the stomach, and he does not regard its presence there as of unfavorable significance. Retention of food in the stomach, with subsequent repeated vomiting, such as attends the so-called "vicious circle," have been associated usually, in our experiments, with kinks and demonstrable obstacles to the easy passage of the food.

KINKS.—By far the greatest number of failures in our experimental gastro-enterostomies have been due to the formation of kinks. When the ease of movement of the intestinal coils one on another is regarded, the possibility of difficulties arising from the permanent fixation of a coil at any point is easily comprehended. Evidence of such difficulties is found in the acute obstructions caused by the kinks and flexures from adhesions between the intestines and the more stationary abdominal viscera.

In the cases of fatal kinking of the intestine observed by us, the trouble has invariably been located at the distal point of that part of the intestine which is attached to the stomach. The intestine beyond this point is ordinarily more

freely movable than the loop between pylorus and stoma. It may be that this freedom of movement favors the kinking, or that the shortening of the stomach as it empties, with the consequent forward pull on the attached intestinal loop, brings about a sharp turn of the gut at the point of junction with the stomach.

Sharp turns in the intestine in normal conditions are undoubtedly readily straightened by the push of intestinal peristalsis. Bayliss and Starling [18] have described a local reflex of the intestinal wall, which requires peristalsis always to be a forward movement. Stimulation of the gut at any point causes contraction behind and relaxation in front of the point of stimulation. A mass of food in the gut must therefore move forward, and as it does so it causes a new region back of it to contract, a new region in front to relax. Thus the mass

FIG. 3.—Diagram showing kink just beyond attachment of intestine to stomach. Note the interruption of the circular fibres at the stoma.

progresses. A mass of food driven forward by a peristaltic constriction must therefore act under normal conditions like the forcible injection of a flaccid rubber tube, in obviating kinks and bends and in making the way passable. It is important to note that conditions for straightening a kink at the end of a gastro-enterostomy attachment are not present. At the stoma there is an interruption of the circular fibres (Fig. 3). The interruption of these fibres makes it impossible to apply to the turn in the gut a force which would make the gut straight. It is evident that the contraction of the interrupted circular muscle can result in no other effect than that shown in Fig. 2, *i.e.*, a shortening of the intestinal wall between the attachments to the stomach. The circular fibres in this region cannot get a grip behind a mass of food and push that mass forward straightening the gut. The only force tending

to obviate the kink is the pressure of the food from the stomach, which in the cardiac end has been proved to be relatively slight. The persistence of kinks near the stoma is thus readily understood. Their effects in producing retention of food in the stomach, vomiting, and death have been observed several times in our experiments.*

Foods leaving by Stoma are not mixed with Important Digestive Juices in the Duodenum.—Food which emerges from the stomach through the pylorus accumulates in the duodenum, and there undergoes the process of rhythmic segmentation.[19] The rhythmic segmentation of the food serves to mix it thoroughly with the pancreatic juice and the bile. The great physiological importance of these secretions, especially the pancreatic secretion, in the digestion of all three classes of food-stuffs—carbohydrates, proteids, and fats—need not here be emphasized. The fact that the presence of the acid chyme in the duodenum is the normal stimulus to the flow of the pancreatic juice[20] is not so widely recognized by surgeons. Thus the food in taking its natural course causes the flow of the digestive secretions and becomes thoroughly mixed with them. If the food, instead of going through the duodenum, passes directly from the stomach into the jejunum or ileum, these functions are seriously interfered with. It is conceivable that a certain amount of pancreatic secretion may be carried into the jejunum and the ileum and there mixed with the food. And food may pass for a short distance into the proximal loop from the stoma. In our experiments food has repeatedly been seen passing from the stroma into the proximal loop (towards A, Fig. 3), only to be swept into the stoma again by a peristaltic wave. Since the circular fibres were not complete at the stoma, the food was not pressed past it into the distal gut, but was forced into the stomach. And no

* We have never observed a reversed peristalsis in the small intestine returning intestinal contents to the stomach. Rosenberg (*Archiv für die gesammte Physiologie*, 1898, lxxiii, p. 419) has assumed this perversion of normal intestinal activity as the cause of vomiting after gastro-enterostomy.

sooner had the wave gone by than the food was pressed back into the proximal loop. Thereupon a new peristaltic wave once more pushed up the food, but back it was pressed when the wave came to the cut fibres. This process, which we have seen repeated again and again, must have the effect of mixing some of the food, at least, very thoroughly with the digestive secretions poured into the duodenum.* But only a relatively small part of the food may be treated in this manner, and at best this is a poor makeshift for the kneading process which normally mixes the juices and the food together.

JEJUNAL ULCERS.—An occasional occurrence in connection with gastro-enterostomy operations is the formation of an ulcer in the jejunum opposite or near the stoma. The cause of such ulceration is not known, although it is commonly ascribed to a digestive process too active for the tissue to resist. When it is remembered that there is a mechanism between duodenum and stomach which prevents fresh food from leaving the stomach until the acid in the food already in the duodenum has been neutralized by bile and pancreatic juice,[21] the presence of ulcers in the jejunum in cases of gastro-enterostomy might well be due to the constant presence of acid in a region in which inorganic acid is not normally found.[22] In this connection it is interesting to note that no case of ulcer of the duodenum after pyloroplasty has been reported.[23]

## CONCLUSIONS AS TO THE BEST COURSE IN GASTRO-ENTEROSTOMY.

From the observations detailed in the previous division of this paper, certain conclusions can be drawn as to the best course in gastro-enterostomy.

DRAINAGE.—It has been shown that there is no reason to suppose that "drainage" from the stomach occurs, in the sense of gravity drainage, but that food is pushed from the stomach,

* Kelling (*Deutsche Zeitschrift für Chirurgie*, 1901, lx, p. 157) has recorded a surgical case in which he was able to observe through a fistula the passage of some of the food into the duodenum from a gastro-enterostomy opening.

as it is pushed elsewhere in the alimentary canal, by pressure due to contraction of muscles in the wall of the canal. In the stomach the most effective muscular activity, peristalsis, is seen only in the pyloric end. Consequently, pressure is greater near the pylorus than anywhere else in the stomach; and food leaves through the pylorus, even the partially obstructed pylorus, rather than through an open stoma some distance away.

The obvious conclusion from these considerations is that the union of stomach and intestine should be made in that part of the stomach in which there is the greatest intragastric pressure, *i.e.*, as close to the pylorus as possible. In the animals observed by us the usual semisolid food invariably left by the pylorus rather than by the stoma, when the pylorus was open and the stoma was near the middle of the stomach. And the only case in which food left invariably by the stoma as well as by the pylorus was a case of gastro-enterostomy in the antrum pylori. If the stoma is to be placed in the most favorable position for use, therefore, it should be placed as close to the pylorus as possible.

The repeated observation of food forced from the stoma into the proximal loop, *i.e.*, in the direction of the gastric peristalsis but opposite to the direction of the intestinal peristalsis (see p. 698), is suggestive of advantages to be derived from a coincidence in the direction of gastric and intestinal peristalsis in the region of the junction. The only case in which this coincidence was followed by an earlier discharge through the stoma than through the pylorus was the case already mentioned on page 690. In this instance the stoma was about midway in the stomach, but the opening was large,—three centimetres in length. In other similar cases with openings only half as large, the food passed out by the pylorus rather than by the stoma. It is impossible to conclude from our cases that the coincidence in direction of gastric and intestinal peristalsis is of great advantage, but a large opening is evidently favorable for use.

"Vicious" Circle.—It has been shown in the previous division of this paper that in simple gastro-enterostomy a

circulation of the food, from stomach through pylorus and back to stomach through stoma, was a frequent occurrence. Especially was this circulation seen when the stomach was well filled. The lips of the opening were thereby widely separated, and the attached intestine stretched so as to become practically a part of the gastric wall. The openings into the intestine at the stoma were then only narrow slits. These are good inlet valves from intestine to stomach, but they prevent easy exit.

The circulation of the food can be rendered less probable by Wölfer's second method (practically the Roux operation) or by a combination of gastro-enterostomy and entero-enterostomy, although in the latter case the circulation is still possible by direct forward peristalsis. One animal on which Roux's operation was performed was observed at intervals for almost three months. Whenever fluid food was given, it invariably passed out both by the pylorus and by the stoma. Proteids combined with fats are very slow in beginning to leave the normal stomach;[24] at one time when salmon was fed to this animal the salmon was seen going out by the stoma earlier than by the pylorus. Never was the law of forward intestinal peristalsis[25] violated, never was there a passage of the food back into the stomach.

With simple gastro-enterostomy and an open pylorus the circulation of the food from stomach to intestine and back to stomach again cannot be prevented. The continuance of such a circulation is clearly favored by stretching the stomach with food. The taking of moderate quantities of food at a time is therefore advisable.

KINKS.—It has been pointed out that intestinal kinks were repeatedly found at the point where the intestine leaves the stomach after being joined to it. These kinks are not readily straightened, because peristaltic pressure cannot be brought to bear upon them, the circular fibres, rendered ineffective by the incision necessary to make the stoma, lie too close to the obstacle.

It is evident that if this reasoning is correct, the rational procedure is to attach a narrow band of the distal gut con-

tinuously to the stomach wall for several centimetres beyond the stoma. The gut is thus prevented from making a sharp turn within a distance in which peristalsis is not effective. Food getting into this region which is kept relatively straight may now be clutched from behind by a peristaltic constriction, and possible bends lying further on in the intestine may thus be straightened by the force of the peristaltic movement.*

Food not mixed with Digestive Juices in the Duodenum.—Food which passes out by the stoma is not mixed with the bile and pancreatic juice in the duodenum. And furthermore this food is not neutralized in the natural manner by the alkaline duodenal fluids. The occurrence of jejunal ulcers near the stoma may be thus explained.

These objections to gastro-enterostomy cannot be avoided, if the operation does what it is intended to do and entirely supersedes the pyloric passage as an outlet. On the other hand, if the food still goes wholly or chiefly through the pylorus the gastro-enterostomy is of little use.

All our observations on experimental animals, and the data collected from the literature, directed us to the pyloric region as the most advantageous location for an artificial outlet from the stomach. The difficulties arising from the circulation of the food by the so-called "vicious" circle, and from the non-mixture of food with the digestive and neutralizing fluids in the duodenum, are practically impossible to avoid in a simple gastro-enterostomy. And the danger from kinks when a movable part of the alimentary canal is fastened as a loop to a less movable or immovable point must always be present. Is not pyloroplasty in cases in which it can be used a much more rationally defensible operation for the relief of

* Kappeler (*Deutsche Zeitschrift für Chirurgie*, 1898, xlix, p. 129) has noted in his cases the passage of food into the proximal loop of the attached intestine, and the failure of the distal loop to function because of the formation of a spur at the stoma. It is interesting to note that from clinical considerations Kappeler recommends (p. 144) fastening both the proximal and distal loops for four to six centimetres horizontally along the stomach for the purpose of avoiding spur formation.

pyloric obstruction than we have found gastro-enterostomy to be?

## PYLOROPLASTY.

The two forms of pyloroplastic operations are the Heinecke-Mikulicz and the Finney operations, although Finney's procedure is sometimes wrongly classified as a gastro-duodenostomy. Both these operations have been performed on animals, and the movements of the food studied by the method already described. As the results, so far as the passage of food from the stomach is concerned, were the same with both operations, a separate consideration of each of them is not necessary.

By the normal mechanism of the pylorus the food is prevented from leaving the stomach until it has undergone gastric digestion. Thus, proteid food, digested in the stomach, does not begin to leave the stomach till later, departs more slowly, and is retained longer, than carbohydrate food of the same amount and consistency, not digested by the gastric juices.[26] And the reflex from the duodenum prevents the chyme from being discharged from the stomach in quantities so great as to overwhelm the important digestive processes begun near the opening of the pancreatic and bile ducts. The chyme emerges at irregular intervals in small amounts, and when a mass of food has accumulated in the duodenum rhythmic segmentation churns the food with the juices.

It is natural to suppose that by cutting the pyloric sphincter the digestive mechanisms controlling the exit of food from the stomach must be entirely destroyed. This supposition is not wholly correct.

When the animals on which pyloroplastic operations had been performed were fed either carbohydrate or proteid food, the discharge from the stomach began earlier and continued in greater abundance than under normal conditions. And although in some cases the duodenum became filled with food, the peristaltic waves continued running over the pyloric end of the stomach. But the discharge into the intestine was not entirely uncontrolled, for the operation does not interfere with the process of rhythmic segmentation in the duodenum (see

p. 702). This rhythmic contraction of the circular fibres of the intestine just beyond the stomach has been again and again observed in these cases of pyloroplasty. It is clear that the process of segmentation alone would check the discharge from the stomach, for the circular constrictions of the gut assume the function of the pylorus, and the gastric peristalsis cannot force the food past them. There is, therefore, in the duodenum a mechanism which serves to control the discharge from the stomach and to continue the mixing of the chyme with the pancreatic juice and the bile in the normal manner.

In favor of the pyloroplastic operations, the facts to be adduced are mainly the obverse of the disadvantages of gastro-enterostomy. In the first place, the food is pressed out of the stomach normally by peristalsis. And after the pyloroplastic operations no circulation of the food is possible,—there is no way back into the stomach except in opposition to the normal movement of intestinal peristalsis. Kinks and sharp turns in the gut have no reason for existence or persistence,—there is no fixation of a free loop of the intestine. And, finally, foods are mixed in a normal manner with the digestive fluids poured into the duodenum. This mixing, by rhythmic constrictions of the intestine, prevents a too rapid discharge from the stomach, promotes the important digestive functions performed by the bile and pancreatic juice, and serves to neutralize the acidity of the chyme with these alkaline secretions.

## SUMMARY.

The stomach is not a passive bag. During digestion the cardiac end slowly contracts, pressing its contents into the pyloric end. Over the pyloric end during digestion peristaltic waves are continually running, churning the food with the gastric juices and forcing the chyme into the intestine. Observations on the functioning human stomach show that as it empties it shortens, especially along the greater curvature. Therefore the part of the stomach lowest when the organ is full or relaxed is not lowest as it empties. The pylorus then becomes the lowest point. Even if "gravity drainage" oc-

curred, the pylorus is the natural outlet so long as the stomach retains its power of contracting.

The pressure within the abdomen is approximately atmospheric pressure. The pressure in any part of the passive alimentary canal depends on the weight of the overlying abdominal organs. If the canal is inactive, the food therefore is as if surrounded by water. Gravity cannot act, and gravity drainage does not occur.

After an ordinary meal, the peristalsis of the pyloric end of the stomach makes the contents of this part more fluid than the contents of the cardiac end. Because peristaltic waves move towards the pylorus, the intragastric pressure is three or four times greater at the pylorus than in the cardiac end. Observations on large cats with gastro-enterostomy openings of various sizes at various parts of the stomach showed that unless the opening, or stoma, was in the antrum (*i.e.*, close to the pylorus) the food, even when fluid, was pushed through the pylorus rather than through the stoma.

With peristalsis only in the pyloric end of the stomach, with the intragastric pressure much greater at the pylorus than elsewhere in the stomach, and with the food in the pyloric end normally more fluid than that in the cardiac end, the food is forced into the intestine through the pylorus and not through the artificial opening, when both ways are offered.

Circulation of the food through the pylorus to the duodenum and back to the stomach through the anastomosis has been repeatedly observed, but it was not followed by the clinical symptoms of the "vicious circle." The circulation was observed best when the stomach was very full. The stretching of the stomach separates the lips of the stoma and draws the intestinal wall into line with the gastric wall. The openings into the intestine at the stoma then become mere slits, and act like valves, permitting the entrance, but preventing the exit, of the food.

The clinical symptoms of the "vicious circle" have been observed in animals in which a kink of the intestine has been found just distal to the anastomosis. Kinks at this point can-

not be straightened by peristaltic activity because the circular fibres of the intestine are cut at the nearby stoma.

It is important that food be mixed with the secretions poured into the duodenum; these juices are highly effective in digestion, and also neutralize the acid chyme. If food leaves the stomach by the stoma, it is not mixed with these secretions. Jejunal ulcers after gastro-enterostomy may be due to the presence of acid in a region in which inorganic acid is not normally found.

From the above considerations, it was concluded that the stoma should be large and as near to the pylorus as possible; that the circulation of the food be rendered less probable by avoidance of overeating, and that so far as possible kinks be obviated, by attaching a narrow band of the distal gut to the stomach for several centimetres beyond the stoma, thus permitting peristalsis to become an effective force.

The probability of a circulation of the food whenever the pylorus is left open, the non-mixture of the food with the digestive and neutralizing fluids in the duodenum, and the ever-present danger from kinks in gastro-enterostomy make the operation not an ideal one.

In pyloroplasty (preferably the Finney operation) these objections are avoided. And a too rapid exit of the food through the pylorus is prevented by rhythmic segmentation of the food in the duodenum, an activity which in part replaces the functions of the pylorus, and also mixes the food with the pancreatic juice and the bile.

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# RESECTION OF THE MIDDLE THIRD OF THE STOMACH FOR CARCINOMA OF THE GREATER CURVATURE.

END-TO-END ANASTOMOSIS; RECOVERY.

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THIS case is of interest because (1) Carcinoma of the greater curvature of the stomach is unusual. According to Fenwick, 58 per cent. of all gastric carcinomata are pyloric. Upon the contrary, but 2.8 per cent. are of the greater curvature. (2) The growth did not infiltrate the submucosa as is commonly the case with pyloric carcinoma. (3) The growth had attained considerable size without causing many symptoms of gastric disturbance, for neither the pyloric nor the cardiac portions of the stomach were invaded. (4) The transverse colon was not involved in the disease. (5) An end-to-end anastomosis was done, using an interrupted Connell suture. (6) The technique of the operation was very greatly facilitated by the employment of clamps according to the methods of Kocher, Hartmann, Mayo, and Moynihan.

F. M. M. entered my hospital service in the summer of 1904. She was thirty-seven years old and married. She was well previous to March, 1904, at which time she began to have spasmodic pains in the abdomen, a little to the left of the umbilicus. These pains persisted for some days and then disappeared. The character of the pain was dull, pressing, deep-seated, below the tumor subsequently discovered. The pain was increased by coughing, sneezing, and bending of the body. On May 30, 1904, not having had any abdominal pain for some weeks, the patient discovered a small swelling to the left of the umbilicus, at the site of the previously described pain. The bowels were regular, and the appetite was fair. She had lost three pounds in weight. She was well developed, only fairly well nourished, and rather thin.

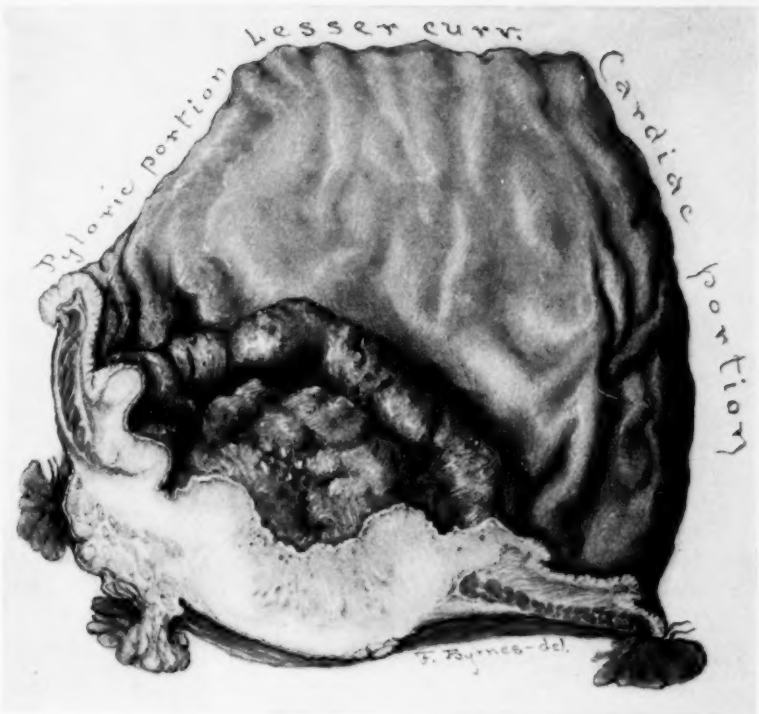


FIG. 1.—Posterior wall of stomach. One-half the portion of the stomach removed. Note the tumor cut in its middle; situation of tumor at greater curvature; normal stomach upon either side of the tumor, towards cardia and pylorus. Note where the growth was attached to the anterior abdominal wall.

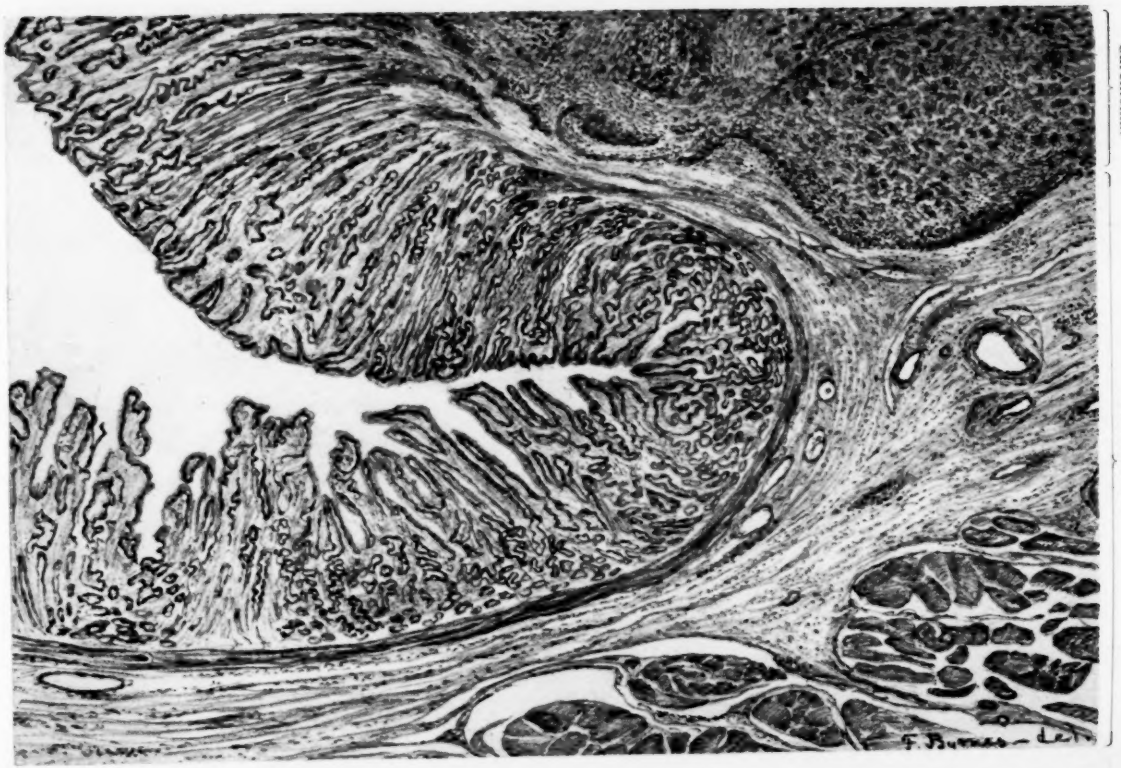


FIG. 2.—Microscopical section taken from the edge of the new growth. Note that the carcinoma is rather sharply defined, and that it does not in this instance extend, as is often the case, beneath the mucous membrane into sound tissue.

FIG. 3.—Showing site of incision, the thin, small woman, and natural appearing abdomen.

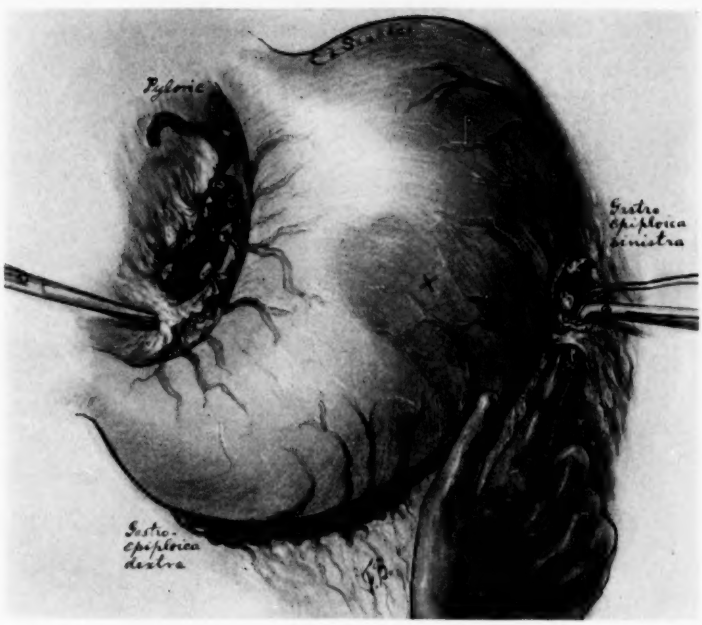


FIG. 4.—The technique of a partial gastrectomy. The pylorus is left in situ. The cross × indicates the situation of the most anterior portion of the growth. Ligature of the gastro-hepatic omentum and of the great omentum. Note blunt instrument tearing open gastro-hepatic omentum preparatory to ligation. Note finger and Cleveland ligature carrier used in tying off great omentum.

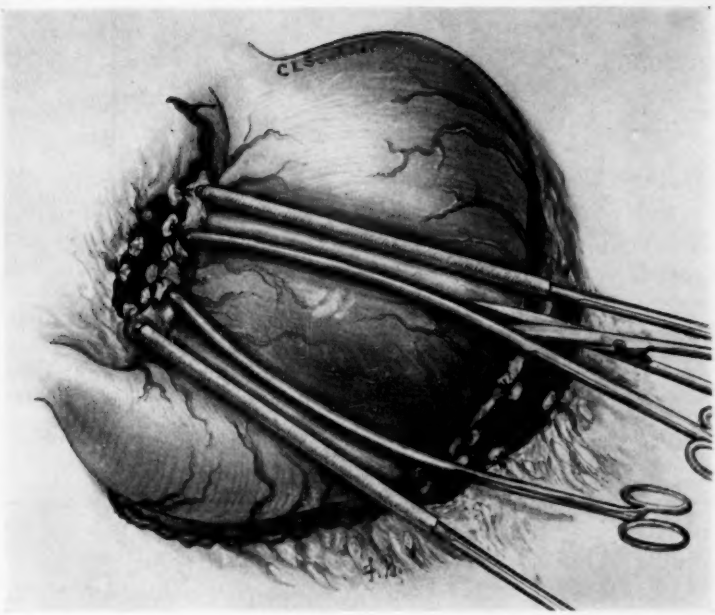

FIG. 5.—Partial gastrectomy. The omenta tied off. Rubber covered compression clamps applied to the most proximal and distal portions of the stomach. Crushing clamps applied to the part of the stomach to be excised. The section is made between both pairs of clamps.

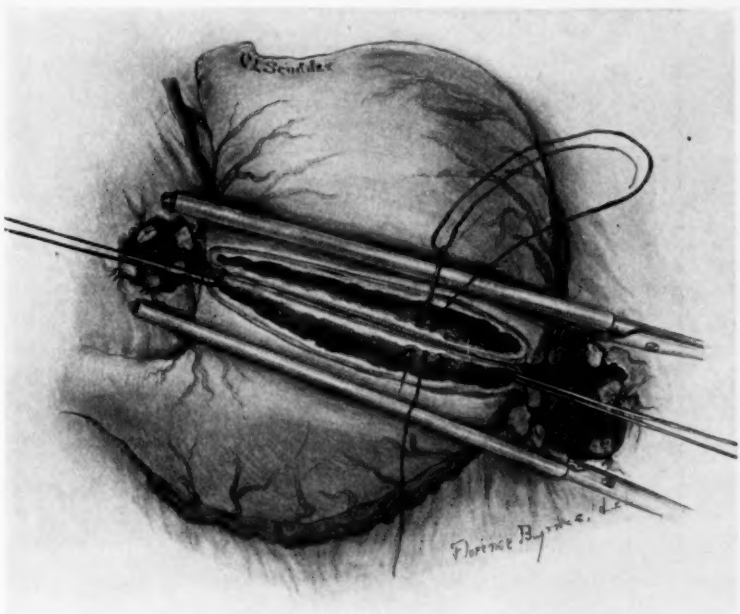

FIG. 6.—Partial gastrectomy. The rubber covered clamps serve to hold the two parts of the stomach approximated together, to prevent hæmorrhage, to prevent soiling of the operation field by stomach fluid. Note Connell interrupted suture being placed. Note two long traction sutures.

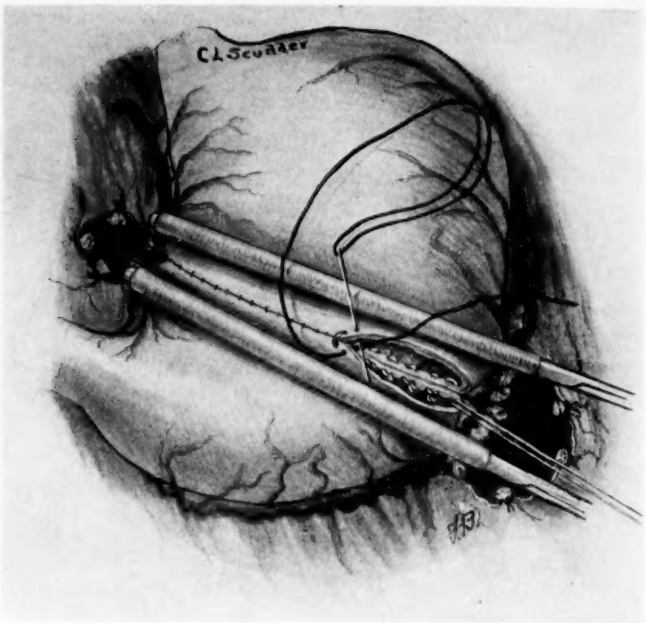


FIG. 7.—Partial gastrectomy. Note clamps and method of employment. Posterior wall completely sutured by Connell suture. Anterior wall partly sutured, one-half of a suture taken, remainder being taken.

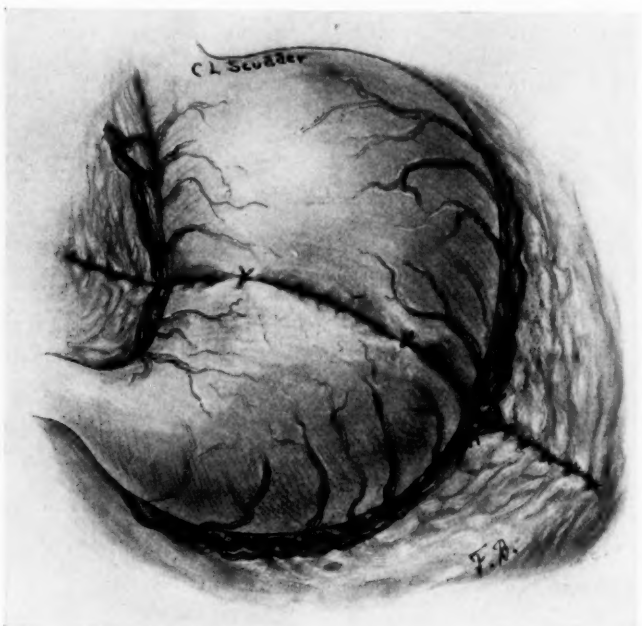


FIG. 8.—Partial gastrectomy. Completed operation. Omenta sutured. Note the four interrupted Lembert sutures to reinforce the Connell suture.

The skin and mucous membranes were pale. Many of the teeth were missing, and those remaining were carious and neglected. Slightly enlarged glands existed in the neck and groin. To the left of the umbilicus was a rounded mass about four inches in diameter, slightly tender, hard, and smooth. This mass was attached to the abdominal wall. It did not move with respiration and was not easily displaced. The percussion note was dull over the mass. Upon inflation of the colon, the dull area of the mass became a little more prominent. The liver extended from the sixth interspace to one inch below the costal margin. The spleen was palpable.

July 1, 1904, the abdomen was opened. The mass which had been felt was found to be slightly adherent to the anterior abdominal parietes a little to the left of the median line. The peritoneum over the mass, from which it was with ease separated, was slightly œdematous. After separating the mass from the abdominal parietes, the parietal peritoneum showed no loss of substance. It was intact. A slight induration existed in the parietes where the mass had been adherent. The omentum was slightly thickened and adherent to the mass. This was separated. The tumor was seated at the middle of the greater curvature of the stomach. The tumor was entirely free and presented no other adhesions to the parts about. The stomach was withdrawn from the abdomen. Gauze packing was placed about the stomach. The gastrohepatic omentum and the great omentum were ligated. The stomach was double-clamped upon both sides of the growth, the middle third of the stomach, including the largest portion of the lesser curvature, was removed, the divided surfaces of the stomach were united by means of an interrupted Connell mattress suture. The suture line was reinforced by one or two interrupted Cushing sutures, a plastic of the omentum was placed both anteriorly and posteriorly to the suture line, the parts were flushed thoroughly with normal salt solution, the walling off gauze was removed and the stomach returned to the abdomen. The abdominal incision was closed with through-and-through silkworm-gut sutures. Except for a slight upset of the bowels, two weeks after the operation, the patient made a good recovery. The temperature did not rise above about 99° F. There was no shock from the operation, and the patient is now taking ordinary food with comfort and benefit. The accompanying figures illustrate the technique and findings of this case.

The feeding of this patient immediately after operation was as follows: She was fed for about one week upon nutrient enemata containing milk, three ounces; one egg; salt solution, one ounce. A nutrient enema was given every eight hours. Each morning a cleansing enema was used, to thoroughly wash the lower bowel. On the fourth day she was allowed water by mouth, on the ninth day liquids, and upon the tenth day soft solids.

*Report of the Hospital Pathologist.*—The specimen consisted of the middle portion of the stomach for its whole circumference. It was, after hardening, four centimetres on the lesser curvature, and on the mid-point nine centimetres in diameter. On opening, on the greater curvature was a rounded ulcer five centimetres in diameter, with raised indurated edges, and a rough, swollen base. On section, the base and borders of the ulcer were composed of hard, grayish, white tissue which had replaced the mucous membrane and the entire wall of the organ for a distance of five centimetres. At the edges the growth was continuous with the mucous membrane and did not tend to infiltrate the submucosa.

Three soft lymph nodes were also received. (*a*) Near the seat of the tumor; (*b*) from the mesocolon; (*c*) from the lesser omentum.

*Microscopic Examination* showed the base of the ulcer composed of solid masses of atypical epithelial cells separated by a small amount of fibrous tissue. These cells had infiltrated the walls of the stomach, extending through them to the peritoneum. They were of small size, closely packed together, with rounded nuclei, many of which were undergoing mitoses. The protoplasm was small in amount, and the outlines not sharply marked. Although the cells in most places were in solid masses, some showed glandular arrangement. The growth was everywhere infiltrated with round cells, and near the surface by large numbers of leucocytes. There was a good margin of normal tissue on each side between the edge of the ulcer and the cut edge of the specimen. Examination of the lymph nodes showed simple hyperplastic lymph adenoid tissue. Diagnosis, carcinoma.

(Signed) CHANNING SIMMONS, M.D.,
*Assistant Surgical Pathologist.*

[NOTE.—At present, April, 1905, some ten months after operation, this patient is in good health.]

# SOME SURGICAL CONSIDERATIONS PERTAINING TO GASTRIC DILATATION.

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THE condition of gastric dilatation is so common and constant a feature of many diseases of the stomach, that it has really come to form quite a distinct position of its own, and one, it would seem, which demands special analysis and definition.

There is a constant and fixed relation existing in the normal stomach between the gastric contents, the muscular ability of the stomach wall, and the resistance offered at the pyloric ring; and it is quite obvious that any change in the elemental dynamics of digestion must lead to a consequential disturbance of function, and that disturbance is usually dilatation, unless, perchance, there should exist a compensating hypertrophy in the musculature of the stomach, which, in spite of the resistance offered at the pyloric ring, still maintains the proper relations, and thus the secondary changes do not occur.

The cause of all gastric dilatation should be sought. If the symptom be due to simple atony, or to the atrophic changes in the gastric muscle, the history may extend over a period of years. Quite in contrast to this statement, if the dilatation be due to some of the mechanical obstructions which are secondary to pathological changes at or near the pylorus, the history may not extend over many weeks or months.

The etiology of gastric dilatation, in general, may be said to arise from two very comprehensive sources. Mechanical forces, obstructing the outlet of stomach, and thus increasing the resistance offered at the ring; and debilitating conditions occurring within the stomach wall, permitting an increase in the volume of stomach contents, which is more or less a

sequence to the inability to bring the contents to a level which permits duodenal drainage or evacuation.

The mechanical sources may be classed as extrinsic and intrinsic; or, causes arising from without and causes occurring within the stomach wall itself. The extrinsic causes may be due to tumors or to pathological conditions of adjacent tissue or organs. Tumors commonly causing pressure on the duodenum or pylorus sufficient to produce a stenosis or stricture may be an enlarged gall-bladder or a gall-bladder filled with calculi, a pancreatic cyst or tumor of the pancreas, omental tumors, growths of the liver, or enlargement of the retroperitoneal glands.

The pathological changes in the adjacent tissue capable of causing gastric dilatation may be a perigastritis which has proceeded from a cholecystitis, or empyema of the gall-bladder. The local peritonitis thus excited by some inflammatory condition of the gall-bladder forms bands of plastic exudate which involve the pyloric end of the stomach, in closest proximity, and which sometimes completely encircle the small end of the stomach in its contractures. This condition was noted twice in a series of thirty-six cases. In one case the provoking cause was simple cholecystitis; in the other, there were noted changes in the gall-bladder, and thirty-four small gall-stones were removed.

Prolapsed right kidney evidently has a very important rôle in gastric dilatation, but whether the dilatation is produced by the displacement of the kidney is at question. Suffice it to say, that the coincidence is far from rare in the observation of many writers.

Bartels was the first to discuss the relation existing between floating kidney and gastric dilatation, and assigned as a cause the production of a kink in the pylorus. My colleague, Dr. A. C. Delacroix, in an experience of fifty cases, found right prolapsed kidney in 25 per cent. of the cases, and prolapsed left and right kidney in 10 per cent. Litten has found this condition in 55 per cent. of his cases. These observations would lead to a belief that it was more than mere

coincidence, and that the descent of the kidney, from any cause whatever, might be associated with gastric dilatation, since it would hardly be probable that the primary dilatation could produce, or be a factor in the production of, malposition of the kidney.

*The Intrinsic Causes.*—By far the commonest cause of gastric dilatation arising within the wall of the stomach is a cicatrix of a corrosion or ulcer; in the event of the former, the cicatrix takes the form of hyperplasia or hypertrophy of the pyloric end of the stomach, or the ring, and is not surrounded by the evidence of so extensive inflammation as is found in the cicatrix of an ulcer, where the adhesions may be attached to the liver or parietal peritoneum without, as well as encroaching upon the lumen of the pylorus within. Polypi may arise from the site of hyperplasia caused by erosion, and may be of sufficient size to obstruct the canal.

*Spasm* of the pylorus may occur for a long time after the healing of a pyloric ulcer, or after an ulcer occurring high in the duodenum, at or near the ring. Such spasm is not, as a rule, continuous, but is extremely likely to be excited after a hearty meal, by the irritation of the passage of the gastric contents over the sensitive scar. When it does occur, it is quite sufficient to produce a lessening of the lumen, and a consequential sagging of the stomach wall.

*Carcinoma* of the pylorus acts in a similar manner as described in the cicatrices of corrosion and ulcer. There is a thickened wall lessening the outlet, and demanding increased force of the musculature of the stomach to expel the stomach contents through the stenosed pyloric ring. This force is gradually lessened by reason of the lowered nutrition, and soon the stomach sags below a point of duodenal drainage.

There remains but one other condition under the head of causes arising from within, and that is so rare that I mention it merely to complete the classification, *i.e.*, congenital stenosis. This was first described by Williams in 1841, and since that time but forty cases are recorded.

The debilitating causes must be considered as atonic, or

conditions due to the temporary weakness of the gastric muscle, and atrophic, or causes arising from a pathological atrophy occurring in the muscle wall.

*Atonic Causes.*—These may be the result of a lowered general vitality, as in convalescence from a long-continued illness, excessive mental strain or worry, which, in turn, produces disturbance of the motor nerve fibres, and the muscle is not sufficiently stimulated by nerve energy to contract enough to empty the contents. The gastric juice has acted upon the meal, and a portion of it—the upper portion—has passed on into the intestines; however, the greater portion is left. The contractures of the stomach become weaker and weaker during digestion, and finally cease; the contents which have been acted upon by the gastric juice ferment; the fermentation produces gas; the gas dilates the stomach, dragging on the nerve endings and producing pain. There is mental dulness, and an occasional attack of severe headache as a result of the disturbed metabolism; further than this, the secretion of HCl is always greatly in excess, and is excited by the presence of this fermenting mass in the stomach.

The atrophic changes follow closely on the heels of the condition described above, and may be said to be produced secondary to long-continued atony where the atrophic changes have taken place as a sequence of a lack of proper nutrition; as a result of neurasthenia, where the motor impulse is impaired, and insufficient use of the muscle produces lowered activity and consequential atrophy; and, lastly, as a result of constant dragging or traction, as in the case of a prolapsed kidney, or a tumor of the lower abdomen, involving the gastro-hepatic omentum, and drawn down by its adhesions.

*Symptoms and Physical Findings.*—Perhaps the most valuable symptom is pain. In the gastric dilatation from mechanical extrinsic sources, or from sources arising from without the stomach wall, the pain depends upon the location and character of the obstruction; for instance, if the obstruction be a large gall-bladder, or is due to perigastric adhesions or tumor of the pancreas, the pain would be an acute, tearing

pain, following shortly after a meal, and occurring during the contractures of digestion. Again, if the obstruction is a tumor of the omentum or liver, or is due to enlarged retroperitoneal glands or prolapsed kidney, the pressure produces an artificial stenosis of the pylorus, and digestion is not completed. In these conditions, the pain is not acute, but is a dull, heavy, dragging pain, which, indeed, it is, as it is the fermentation of the gastric contents retained by reason of the disturbed dynamics—a stenosed orifice—which produces gas sufficient to dilate the stomach and drag on the peripheral nerve endings. This pain is usually relieved by taking bland food, or sometimes even a drink of water, and it is in these conditions, in conjunction with the same symptoms following the disturbance of gastric tone, that the laity learn to use solutions of sodii bicarbonas; the alkali neutralizes the excess of HCl, and gas, in large quantities, is expelled, and the symptom of pain subsides or entirely disappears.

The character of pain conspicuous in the intrinsic causes is more typical. In cicatrices of corrosions and ulcers, the pain is acute, short, and very severe. Fenwick states, in his "Résumé of 3679 Cases" (1904), that pain is frequent and severe where the walls of the curvature are the site. Growths of the cardiac end are least painful. Pain is greatest after meals.

In the case of polypi arising near the ring, the pain would be more of the character described under extrinsic causes. In other words, it would produce a dull pain, due to the excessive dilatation of the stomach.

Spasm of the pylorus is an acutely painful seizure, but can readily be recognized by the short duration, great severity, and irregularity. In carcinoma, pain is early and, in most cases, is a continuous symptom, varying in severity according to its proximity to the pylorus. The first pain may be dull and oppressive, but later it becomes more acute, simulating the character of the ulcer pain. Pain in the cases proceeding from debilitated muscle wall is, as a rule, due to the excessive fermentation induced by the inability of the musculature of the stomach to evacuate its contents.

It will be observed, then, that the pain in gastric dilatation is sharply defined under two distinct heads. If it be acute, we think of ulcer, perigastric adhesions, gall-bladder encroachments, cicatrix of either ulcer or corrosion, spasm of the pylorus if irregular, and carcinoma. Such pain is increased by eating or drinking, as a rule.

If the pain be dull and dragging, and if it be relieved by taking bland food, or by sodii bicarbonas, we can assume that it is due to obstruction, either from pressure exerted from without, as, for example, tumors, prolapsed kidneys, etc., or it is a consequence of an incompetent muscle wall.

Vomiting is a most significant feature. It accompanies ulcer, stenosis (if severe), spasm, carcinoma, and the more intimately related extrinsic causes, as gall-bladder disease and perigastric adhesions.

In emphatic contrast, it is very rare that vomiting will occur in cases due to the impaired gastric wall. These patients will tell you that they never vomit. In a series of thirty-six cases, I have failed to get a history of involuntary vomiting in a single case, no matter how much they feel the need of it. They seem to find it impossible to empty the stomach by emesis. Consequently, you will find the majority of them using stomach-tubes, having been taught its use by their physician, or they drink large amounts of water, and provoke emesis by tickling the pharynx, or by irritation with the fingers.

The physical findings in gastric dilatation need only to be passed in review, since the ordinary methods of physical examination apply in these cases. Perhaps the commonest physical finding is a splashing on succussion. The symptom is constant, and is exaggerated relatively to the extent of dilatation; one precaution in regard to the reliability of this symptom is its absence after meals, for, as a rule, the relieved stomach rises to nearly its normal position, and the splashing will not be heard.

Quite naturally, the capacity of dilated stomachs is increased in exact ratio to the extent of possible laxity of the stomach wall.

The stomach may be filled with water or air, and then, by means of percussion and observation, its contour may be mapped out. If the patient is prone and the stomach well filled, the marked protuberance of the surface in the epigastric triangle will be noted, and, if water has been used, careful measurement of the contents siphoned after percussion will give the relative increase in size. An examination for prolapsed kidney should be made in all cases in the course of the physical examination, and nephropexy should be included in the operative procedures for relief.

The uses of the Lockwood light, or Gastrodiaphane, was described by Kemp in April, 1904. His method is founded on a series of experiments, and is as follows: Sodii bicarb., grs. xv–xx, is dissolved in a glass (eight ounces) of water; the patient is given this solution in order to neutralize the acidity of the gastric contents. This is immediately followed by another glass (eight ounces) of water, in which are dissolved grs. xv–xx sodii bicarb. and one-eighth gr. of fluorescin. The patient is then taken into a dark room and a Lockwood light, or Gastrodiaphane, is introduced in a manner similar to a common stomach-tube; it is, however, much smaller, and can be manipulated without producing very much gagging or attempts at vomiting. The light is very brilliant, and, contained as it is in a fluorescent medii, the entire stomach can be made out, the lower border located, tumors or hypertrophy of the pylorus identified, and tumors of the liver, the transverse colon, and the omentum covering the area of illumination, can be detected. Kemp has also had excellent results from the use of quinine bisulph., grs. x, dissolved in eight ounces of water, to which are added five minims of acid phosphoric dilute, and this is followed by another glass of water.

The chemical and microscopical findings in gastric contents examination do not require any comment from me at this time; suffice it to say, that no stomach examination is complete without gastric contents examination.

After all, the best and most satisfactory means of reaching a positive diagnosis is by exploratory laparotomy. This re-

veals the conditions as they are, eliminates all guesses, does away with all hypotheses, and leads the surgeon straight to the seat of the trouble, besides sparing the patient weeks, months, possibly years, of a semi-invalid existence, which he barely tolerates, and during which he is the constant object of the concern, sympathy, and solicitation of his friends and family.

Mere exploration will reveal the extrinsic causes of gastric dilatation, and the diagnostic exploration can be converted into curative operation without further inconvenience or delay. The tumors encroaching upon the duodenum or pylorus may be removed, the perigastric adhesions separated, the cicatrices of corrosions or ulcers palpated, a polypus identified, carcinoma recognized, and surgical procedures undertaken which will most nearly restore the function of the part to normal. Should it be impossible to remove the encroaching tumor, the operation of gastro-enterostomy is clearly indicated. Whether by suture, Murphy button, McGraw ligature, anterior or posterior operation, these important details must be decided according to indications and operative selection.

In stricture or stenosis of the pylorus, proceeding from corrosion or hyperplasia, the operation of pyloric dilatation is to be attempted. This can be done, sometimes, by invagination through the wall of the stomach as practised by Hahn. Loreta made an operation known as "Pylorodiosis," in which he dilated the pylorus ring through an incision on the anterior wall of the stomach. The dilatation was accomplished by stretching with the fingers, and, while apparently a simple procedure, was followed by a mortality rate that would hardly commend it to the conservative surgeon.

Pyloroplasty was originated for the same class of cases. The simple, perpendicular incision, and the longitudinal suture of the same, was modified by Mayo Robinson introducing a bone bobbin into the lumen of the ring.

Unquestionably, the operation of choice in this condition is gastro-enterostomy, unless sufficient dilatation can be had by invagination. Gastro-enterostomy, or Finney's operation

of gastroduodenostomy, is equally as well suited in cases of cicatrices of corrosion or ulcer, providing the cicatrix is on the anterior surface of the stomach. Where the cicatrix is found at or near the pylorus, gastro-enterostomy is to be preferred. Pylorectomy, or partial gasterectomy, is obviously indicated in carcinoma where the growth occurs at or near the pyloric end.

In meeting the requirements for restoration of impaired function due to atony or atrophic changes in the muscularis, the simplest procedure that promises the greatest restoration, and at the same time does not in any way endanger the patient, is, perhaps, gastroplication. The greatest objection to this operation in the past has been the fact that it leaves the mucosa either in rugea or one large fold, which gives opportunity for the retention of fermenting contents of the stomach, thus producing a recurrence of the symptom. In the last three cases of gastric dilatation due to the impaired stomach wall, the writer has modified the standard operation, which procedure overcomes these objections. Sufficient time, however, has not elapsed to warrant a description of the operation. The last case was operated June 4. In each instance very satisfactory results have followed. The success of the operation, however, is dependent upon two very important factors, *i.e.*, patency of the pyloric orifice, and the ability of the gastric muscle to regain its normal tone.

# GUNSHOT WOUND OF THE PANCREAS.

REPORT OF CASE, AND REVIEW OF LITERATURE.

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*Synopsis of Case.*—T. R., aged twenty-one years, an American, miner, was shot in the abdomen, during a struggle for the possession of a .32-caliber revolver, at about 4 P.M., on December 13, 1901. He arrived at St. Vincent's Hospital, Leadville, two hours after the accident. Examination revealed a gunshot wound on the right side, midway between the axillary and mammillary lines, at about the seventh costal cartilage. Pulse, 100; temperature, 99° F., and respirations, 20.

He complained of intense colicky pain in the abdomen, chiefly in the region of the umbilicus. The entire abdomen was tender, but this was most pronounced above the umbilicus in the median line. There was present no distention, no marked rigidity of the abdominal muscles, the liver dulness was normal, and no evidence of fluid in the abdominal cavity. The patient was very restless, and continually rolled from side to side, crying for something to relieve the pain. During the examination, he vomited for the first time, and fresh red blood was found with the vomited matter. Laparotomy was performed one hour after admission to the hospital, three hours after the injury. Dr. J. A. Jeannotte assisted, and the late Dr. R. J. Gregerson administered the anæsthetic.

Exploration disclosed a through-and-through wound of the right lobe of the liver and a perforating wound of the stomach at its lesser curvature. These wounds were closed by suture, the through-and-through suture of the stomach wall was re-enforced by a suture of the lesser omentum. Examination of the large and small gut, the kidney, and the spleen was negative. The abdomen was then closed without irrigation or drainage. Recovery from the anæsthetic and the shock of the operation was satisfactory.

The next day, the 14th, the highest temperature was 101.2° F.; pulse 120 to 130, and the respirations from 16 to 20. There was quite a little nausea, some vomiting, but no hæmatemesis; slept for a short time at frequent intervals. The condition on the 15th was similar to that of the previous day in all respects; the pulse was never below 120, and the temperature was 102° F., at the highest, in the afternoon. There was no vomiting nor nausea, and the rectal enemata were well retained. During the night, restlessness gradually became marked; the pulse very rapid, and the temperature in the rectum went up to 102° F.; respirations were about 30; he became unconscious, and was in a muttering delirium. Physical examination of the abdomen was negative; there was no evidence of peritonitis, nor of hæmorrhage. The temperature became subnormal before death, which took place at about 3 A.M. on the 16th, sixty hours after the shooting.

Partial autopsy, six hours after death. No signs of peritonitis. Upon separating the gastrohepatic omentum where it had been sutured over the wound of the stomach, the stitches of the stomach wound were plainly visible, and for one-eighth of an inch on each side of this line of suture the stomach wall was of a dark, slaty color; in marked contrast to the shiny peritoneum elsewhere. In the centre of the sulcus there was a thin layer of thick, viscid, grumous, slate-colored material. There was positively no attempt at union between the apposed serous surfaces of the stomach wall, but there had been no leakage of stomach contents, because the sutures held the inverted margins in position. There was a small amount of serosanguinolent fluid in the lesser peritoneal sac. The pancreas was badly damaged by the passage of the bullet, the track of which was plainly visible, to the left of the middle of the body of the organ. The lining of this opening through the pancreas was dark in color, soft, and necrotic; surrounding this narrow zone of necrosis the pancreatic tissue was hard and mottled with red. The bullet was removed from the retroperitoneal tissues to the left of the second lumbar vertebra. There was no necrosis of the tissues that surrounded the bullet. The wounds of the liver were normal, as was also the laparotomy incision. (Figs. 1 and 2.)

This case is instructive from more than one point of view, for instance: A. The failure to detect a serious lesion of an

important organ intimately associated with the injured viscera. B. The condition of the stomach wound. C. The treatment.

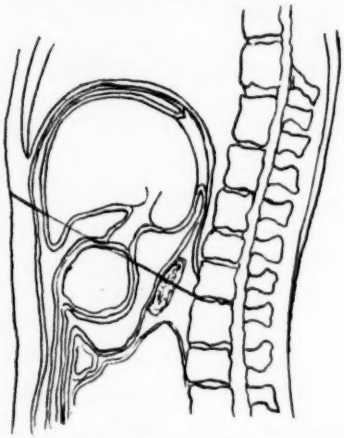

FIG. 1.—Anterior posterior direction of bullet track.

A. As to the frequency with which this oversight has taken place, we may quote from Mikulicz:[1] "We often find cases reported where wounds of the stomach or intestine having

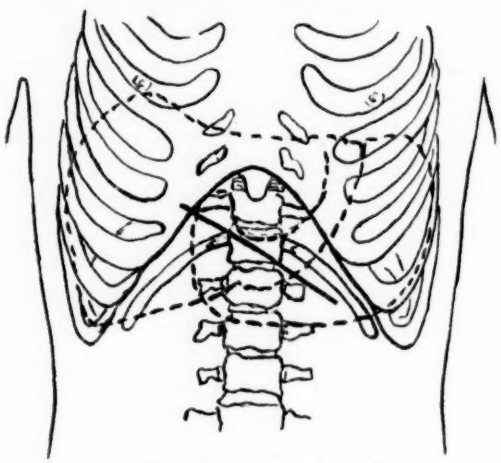

FIG. 2.—Lateral obliquity of bullet track.

been sutured, death has occurred from an undetected wound of the pancreas."

As to why this should be true, there are a number of explanations which might be advanced, such as:

(*a*) The prevailing opinion that the pancreas is rarely, if ever, injured, and that, if so, the wound is almost invariably fatal. Boeckel,[2] for example, in discussing Ceccherelli's paper at the International Congress of Medicine in 1900, said, "Les blessures du pancréas sont généralement mortelles d'emblée." And Michaux,[3] in the same discussion, concludes, "Que les ruptures du pancréas sont au-dessus des ressources de l'art." And from the *Philadelphia Medical Journal*,[4] in an editorial, "Wound of the pancreas which is usually immediately fatal."

(*b*) Without doubt, Mikulicz[5] explains a very frequent cause in saying, "When the abdomen is opened in such cases, the accompanying injuries of the surrounding parts almost always demand such attention that the lesion of the pancreas is easily overlooked."

(*c*) But perhaps the most important cause is the anatomical position of the organ and the consequent difficulty of a thorough examination.

All of these points tend towards a neglect of this organ in cases of traumatism of the upper abdomen.

There are five routes mentioned by Park[6] by means of which the pancreas may be approached; of these, three may be applicable for examination, *i.e.*, (1) above the stomach, through the lesser or gastrohepatic omentum; (2) below the stomach, through the greater or gastrocolic omentum; (3) behind the stomach and colon, through the transverse mesocolon.

B. Condition of the stomach wound. Non-union of approximated serous surfaces may be due to various causative factors, but when this condition is found in conjunction with a wound of the pancreas it does seem rational to assume that the non-union has been caused, in part at least, by the action of the pancreatic juice upon the tissues at the site of the imperfect healing. The properties of the pancreatic juice, in some particulars, are still more or less obscure. While its action upon food substances within the intestinal canal is well recognized and definite, its action upon different structures of the living body is still more or less vague and indistinct. We

may consider its action upon (1) epidermis, (2) deeper structure, (3) granulation tissue, (4) peritoneum.

1. The effect of the pancreatic juice upon the skin has been noted in many cases of high intestinal fistulæ, in drained pancreatic cysts, and, experimentally, in pancreatic fistulæ. Almost invariably with all of these conditions there results an irritation, and, finally, a destruction of the epidermis, which is in prolonged contact with the fluid discharged from the fistulous opening. This effect is supposed to be due to the digestive action of the pancreatic juice.

2. The digestion is confined to the superficial layers of the skin, the epidermis alone is destroyed in this manner, the destruction of cells does not extend deeply but peripherally. The cutis vera and the subcutaneous structures seem to be able to resist the digestive action of the pancreatic juice. The deeper structures may show signs of irritation or of inflammation, but whether this is due to the irritation of the pancreatic juice, or an irritation subsequent to a deprivation of its normal covering, the epidermis, cannot be definitely stated; but these underlying structures are not digested and removed as are the cells of the cuticle.

3. Granulation tissue is usually formed after the superficial layers have been removed; and it has been found that the cells of this tissue are able to withstand the presence and the action of the escaped pancreatic juice. One explanation for this difference in behavior of the pancreatic secretion on the epidermis and upon the true skin and granulation tissue may be found in a possible absorption of the digestive juice by the vascular tissues after the superficial layers have been removed. Or perhaps a better in a theory advanced by H. W. Cushing,[7] of Boston, to the effect that the epidermis is composed of cells with practically no vitality, hence the digestion, which is not possible in living, vascular, deeper cells, peritoneum, or granulation tissue.

4. On account of the marked effect of the pancreatic juice upon the skin, it was naturally to be supposed that this same fluid would cause a reaction greater, or at least equal,

upon the much more sensitive peritoneum. But early in the era of pancreatic experimentation, Claude Bernard,[8] in 1855, found that when the pancreatic juice escaped into the peritoneal cavity there was practically no peritonitis as a result.

Heidenhain subsequently confirmed this observation, and is quoted by Senn[9] as follows: "The animals do not suffer from this circumstance, as the duct is regenerated in spite of the wounded surface being bathed in the secretion. Nevertheless, it is difficult to explain this. Why do not the wounded and suppurating tissues undergo digestion by the pancreatic juices?" And Senn,[10] in 1886, also verified these findings.

After the experimental establishment of internal pancreatic fistulæ, he concluded that, "Extravasation of fresh normal pancreatic juice into the peritoneal cavity does not produce peritonitis, but is promptly removed by absorption." In 1888, Martinotti,[11] after the experimental removal of the pancreas, arrived at the same conclusion. And in 1897 Flexner[12] said, "The secretion of the pancreas *may* enter the peritoneal cavity without setting up a diffuse inflammation."

Cushing,[13] in 1898, said, "It is hard to understand why the fluid digests epidermis and not granulation tissue or peritoneum."

Ceccherelli,[14] in 1900, said, relative to this point, that his experience was in accord with that of Senn and Martinotti. He further stated that the pancreatic juice cannot cause peritonitis if it is pure, as it is rapidly absorbed. But if altered it may produce septic phenomena.

In 1903, at the Congress of American Physicians and Surgeons, Mikulicz[15] said, "The point as to whether or not this leakage is injurious was only recently definitely settled. After the experiments and experiences of recent years, we can no longer doubt that such leakage is indeed harmful. The experimental studies of Williams, Flexner, Biondi, Katz and Winkler, and others, show clearly that injuries of the pancreas, through which the vitality of a part of the organ is impaired, and the flow of pancreatic juice towards the pancreatic duct is hindered or ceases entirely, seriously affect the peritoneum

and the neighboring tissues." . . . "If we ask ourselves whether the secretion from the injured pancreas leaking into the abdominal cavity can of itself so damage the peritoneum that death from this cause alone may result, we must surely admit that this is a possibility, as shown by a number of experiments and clinical observations of accidental injuries in man." . . . "It seems, moreover, that the secretion from the injured or also inflamed pancreas without bacterial invasion can cause a variety of aseptic peritonitis." . . . "Blood and pancreatic secretion ooze into the peritoneal cavity, preventing the formation of peritoneal adhesions."

The above is quoted at length, for it is a statement of the generally accepted facts to-day, and was stated by, perhaps, the foremost authority upon the subject at this time, before the representative physicians and surgeons of America. And while directly opposite to the previous teachings, it is what might be expected from a theoretical stand-point.

The condition of the stomach wall in the case under consideration may possibly be explained, in the light of the most recent investigations, somewhat as follows:

That the pancreatic fluid escaped into the peritoneal cavity cannot be doubted. Its presence did not cause a general peritonitis. The site of the gastrorrhaphy and the lining of the track of the bullet through the pancreas were superficially necrotic. There must have been some reason why this localized necrosis took place while the rest of the abdominal cavity remained practically normal.

The location of these destructive changes would lead to the belief that possibly the digestive juices of the stomach or intestine might have acted as predisposing or aiding factors. The pancreatic juice must have passed over, and had no appreciable effect upon, a large portion of the serous covering of the stomach. No destructive action was noted till the site of the perforation was reached; at this point the gastric juice and the fluid from the injured pancreas might have combined with a resulting destruction of tissue. The suture of the lesser omentum over the stitches in the stomach proper seems to have been no protection.

The necrosis along the path of the bullet in the pancreas is not so difficult to explain. The altered pancreatic juice and blood alone might have been able to produce the change; or infective matter, or stimulants to the pancreatic ferments, might easily have ascended to the wound by means of the common duct and the duct of Wirsung. The fact that the cavity in which the bullet rested was not necrotic might be explained by the presence of some obstruction in the track which prevented the fluid from gravitating into this final lodgement of the missile. The normal condition of the wounds of the liver and that of the abdominal wall may be explained by the dorsal position of the patient and the lack of contact with the fluid from the injured pancreas.

On the other hand, it may be that the intestinal or gastric secretions had nothing whatever to do with the change, and that the mere suturing, or the passage of the bullet, caused sufficient trauma to prevent the tissues from resisting or counteracting the action from the damaged pancreas. In 1898, Williams [16] suspected that the pancreatic juice may be possessed of irritating properties which make the tissues in contact with it extremely liable to infection. And Mikulicz [17] said, " But if the vitality of the peritoneum has been impaired by the action of the pancreatic secretion, then a limited number of bacteria are sufficient to cause peritonitis."

In an attempt to study this question, the writer made various experiments on dogs, in which, to the establishment of an internal pancreatic fistula, there was added traumatism of the adjacent peritoneum, and in some instances the endothelial layer was entirely removed. But in none of these cases was there any apparent effect of the pancreatic juice upon the injured or denuded areas. In others the pancreas was injured, so that, without doubt, its secretion escaped into the peritoneum, and then a suture, or rather a seton, was passed into the lumen of the adjoining stomach or duodenum and tied with a large knot in the peritoneal cavity. The results were various, but in no case was there any localized peritonitis or gangrene comparable to that in the case reported.

Popelsky [18] has proved to his satisfaction that the pancreatic juice alone cannot digest proteids; but when brought in contact with intestinal secretion, however, its protypdin is converted into trypsin, and the latter successfully attacks proteids. This would seem to be questionable when it is remembered that the fluid from a retention cyst of the pancreas, which certainly does not communicate with the duodenum, when drained has been known to digest the epidermis of the skin adjacent to its place of exit.

Pawlow [19] discovered a new enzyme in the gastric secretion, a specific ferment called "chymaze," which does not digest food, but which accelerates the action of the ferments of the pancreatic secretion.

Pawlow and Chepowalinkoff [20] have shown that the pancreatic activity may be increased by the addition of an extract of intestinal mucosa or succus entericus. This is accomplished by a body called "enterokinase." The terms enterokinase and chymaze seem to be used interchangeably in the literature. It may have been the presence of this chymaze or enterokinase at the wounds that stimulated the pancreatic secretion to a greater activity which caused the necrosis; and its absence from the adjacent peritoneum may account for the lack of action by the same fluid.

C. Treatment. The most important element in the treatment is the finding of the condition. And in order that it may not be overlooked, it must be borne in mind that the pancreas may possibly be damaged in each and every case of injury of the upper abdomen. Examination with such a possibility in mind will but rarely fail to detect the lesion, if present. When a lesion of the pancreas is found in a case of gunshot wound, the treatment will consist of suture or drainage.

Suture alone has but little in favor of it, on account of the deep position of the organ; sutures are properly placed only with great difficulty; the structure of the pancreas is not suitable for the holding of stitches, and even with careful suturing the coaptation is apt to be faulty, with a consequent leakage.

On the clinical side there is recorded but one case in which this line of treatment, *i.e.*, suture alone, was employed. And this made an uneventful recovery. When suture of the damaged viscus is possible and practicable, without prolonging the operation too long, it should be done, and the drain brought to the site of the suture.

Drainage has been employed in the great majority of these cases; and it is a noteworthy fact that in the two instances where a localized destruction of tissue occurred drainage was not instituted.

Leakage of fluid from the damaged organ is almost certain to occur, either into the retroperitoneal structures or into the free peritoneal cavity. And as it is certain that this fluid will do less harm outside of the body than in either of these locations, it is therefore advisable to drain each and every case, and even in suspected cases, if the condition of the pancreas has not been definitely determined upon. Tubular and gauze drains have each been employed, but the best drainage is undoubtedly obtained by a combination of gauze and a tube.

In all of the reported cases except Jepson's, the drainage has been effected through the anterior abdominal wound, but as a much more perfect drainage can be maintained by means of a posterior opening (R. Park),[21] it is therefore to be recommended as an additional safeguard in all cases of pancreatic injury. Case XVIII (Jepson) must be looked upon as a model for treatment of gunshot wound of pancreas.

The following cases are all that have been reported in available literature to date, and for fifteen of these we are indebted to the very able article by Borchardt.[22]

CASE I.—OTIS. Medical and Surgical History of War of the Rebellion, Part II, Vol. ii, page 159. Wound of entrance, six inches to the left of the spinal column, below the eighth rib. Wound of exit, none. Symptoms, pulse good, slightly irritable. No marked symptoms for two weeks, then hæmorrhage from the wound, with hæmaturia repeated. Result, death one month after the receipt of the injury. Course of the bullet, spleen and pancreas.

CASE II.—IBID. Wound of entrance, one line to the left and below ensiform. Wound of exit, just above the crest of the ilium. Symptoms,

pulse quick and feeble, abdomen distended and tympanitic. Result, while feeling much better, death occurred suddenly on the fifteenth day. Course of bullet, inferior curvature of the stomach, about the middle of the pancreas. Omentum was in a state of partial decomposition, with general peritonitis.

CASE III.—OTIS. Wound of entrance, below spine of left scapula, an inch from shoulder-joint. Wound of exit, none. Symptoms, emphysema, pronounced jaundice on eighth day. On the ninth day, profuse hæmorrhage from the nose and mouth. Pulse weak and thready. Result, death on twelfth day. Course of bullet, scapula, fifth rib, left lung, lower lobe, diaphragm, liver, left lobe, and pancreas.

CASE IV.—SANITAS. Report of German Army in War, 1870–1871. Wound of entrance, left of body of eighth vertebra. Wound of exit, left of navel. Symptoms, coughing of blood, suppuration of the posterior wound. Result, death on the twenty-fifth day. Course of bullet, fracture of the eighth rib, spleen, and pancreas.

CASE V.—NIEMANN, MAYER. Wound of entrance, beneath ensiform process. Wound of exit, between second and third false ribs near vertebra. Result, immediate death. Course of bullet, heart, diaphragm, liver, and pancreas.

CASE VI.—BERTRAM. Inaug. Diss., Jena, 1893. Wound of entrance, first, between navel and ensiform; second, sixth intercostal space, left mammillary line. Wound of exit, none. Symptoms, hæmatemesis, hæmoptysis, hæmaturia, collapse. Result, death. Course of bullet, first, stomach and head of the pancreas; second, diaphragm, twelfth rib, spleen, and left kidney.

CASE VII.—VON BRAMANN, WEIMUTH. Archiv f. klin. Chir., Vol. lx, 1899, 1900, page 482. Wound of entrance, under angle of left eleventh rib. Wound of exit, none. Symptoms, brought to hospital three hours after injury; general findings good. Six hours later, hæmatemesis twice. Operation, nine hours after injury. Course of bullet, through stomach, mucous membrane prolapsed, bullet found in pancreas. No stomach contents in abdomen, but a teaspoonful of blood. Treatment, suture of stomach wound, site of suture tamponed, wound of pancreas likewise tamponed. Result, recovery.

CASE VIII.—IBID. Wound of entrance, under costal arch midway between sternum and left mammillary line. Wound of exit, none. Symptoms, brought to hospital six hours after injury, one-half hour later hæmatemesis. Operation, eight hours after accident. Course of bullet, through the stomach and into the pancreas. Some stomach contents in abdominal cavity. Treatment, suture of the stomach wound, surrounding the same with gauze. Pancreatic injury also packed with gauze. Result, recovery.

CASE IX.—E. HAHN. Deut. Zeit. f. Chir., Band lviii, 1900, 1901. Wound of entrance, left of median line at the height of the seventh and eighth costal cartilage. Wound of exit, bullet found under the skin, at about a level with the left kidney. Symptoms, pulse small and rapid; belching of gas but no vomiting; marked anæmia and prostration; dul-

ness in the left half of the abdomen. Operation, laparotomy for hæmorrhage shortly after admission, which was one-half hour after accident. Course of bullet, through left lobe of liver, through lesser omentum, through the transverse mesocolon into pancreas; stomach uninjured. Treatment, cleaning of the peritoneal cavity, and packing the track of the bullet with gauze. One strip of gauze in the anterior wound of the liver; a second in the posterior wound of the liver; a third in the opening of the gastrohepatic omentum, and another in the opening of the mesocolon, and into the retroperitoneal effusion of blood. Result, recovery.

Case X.—G. Nini. Cent. f. Chir., No. 41, 1901, page 1024. Wound of entrance, right of second lumbar vertebra. Wound of exit, right epigastric region, between mammillary and parasternal lines. Symptoms, ran 500 yards after the receipt of injury. Brought to hospital collapsed, almost unconscious; pulse thready; abdomen painful and tympanitic. Operation, opening of the peritoneum was followed by the escape of blood and gas, eight wounds of gut were sutured. In making toilet, found blood oozing from between the stomach and the transverse colon; a transverse incision from umbilicus to the right axillary line, and tearing through the gastrocolic omentum, revealed a wound of the pancreas at the junction of its head and body. Course of bullet, pancreas, six wounds of small intestine, one wound of hepatic flexure of colon. Treatment, two deep sutures of the pancreas, no drainage. Result, recovery.

Case XI.—M. Borchardt. Berl. klin. Woch., January, 1904, No. 3. Wound of entrance, epigastrium, left of median line. Wound of exit, none. Symptoms, extreme nervousness; marked pallor; pulse good; vomited blood. Operation, four and one-half hours after accident, upon opening the peritoneum, blood shot out, and the pulse disappeared. Course of bullet, left lobe of liver, portal vein, tail of the pancreas, vena lienalis were torn and bleeding. Treatment, suture and drainage (gauze packing). Result, recovery.

Case XII.—Von Bramann, Weimuth. Ibid. Wound of entrance, one centimetre to the left of the end of the ensiform cartilage. Wound of exit, none. Symptoms, one-half hour after the accident, vomited three times; no blood; came to the clinic next morning. Patient strong but pale; pulse strong but small. Slight tympanites; dulness over the left lobe of the lung, with some dyspnœa. Dulness likewise in the epigastrium and the left hypochondrium. During the last few hours before operation postoperative symptoms. Death occurred on the ninth day. Autopsy laparotomy, twenty hours after the accident. Liver bleeding freely, about one and one-half litres of blood in pelvis. Gastro-intestinal canal negative. Course of bullet, through liver and lesser omentum, and disappeared in the body of the pancreas. Treatment, wounds of liver and pancreas tamponed with iodoform gauze. Result, death thirty-three hours after injury.

Case XIII.—M. Simmonds. Mün. med. Woch., 1898, No. 6, page 169. Wounds of entrance and exit not given. Symptoms, those of internal, peritoneal, hæmorrhage. Operation, laparotomy two hours after the injury. The source of the bleeding was not discovered, and, as it stopped

spontaneously, the abdomen was closed. Result, patient went into collapse, and died thirty-six hours after the operation. Course of the bullet, as shown by the autopsy, was through the pancreas; the vena lienalis were opened. Fat necrosis was noted.

CASE XIV.—MANN and MYNTER. American Medicine, October 19, 1901. Wound of entrance, midway on a line from left nipple to umbilicus. Wound of exit, none. Symptoms, pulse getting weaker, with a perforating wound of the peritoneal cavity. Operation, one and one-half hours after the injury. Course of bullet, anterior wall of stomach, posterior wall of same; palpation of the deeper structures behind the stomach revealed no trace of the bullet or its track. Treatment, both wounds of the stomach were sutured and the abdomen closed without drainage. Result, with the exception of a gradually weakening pulse, there were no marked postoperative symptoms. Death occurred on the ninth day. Autopsy revealed additional injuries to the pancreas and left kidney, also extensive necrosis of the pancreas and the gastric wall in the neighborhood of both wounds.

CASE XV.—KORTE. Verhand. der Freien Chir., Verein, Band xiii, p. 87. Wound of entrance, below the costal arch, to the right of the middle line. Wound of exit, none. Operation, laparotomy, eight hours after the injury; much blood and intestinal contents in the abdominal cavity. Course of bullet, through the colon, the mesocolon, into the head of the pancreas; a loop of the small intestine was shot through in many places. Treatment, resection of the small intestine was necessary. Result, death a few hours later. Autopsy, fat necrosis was present.

CASE XVI.—K. G. SLAVSKY. Roussky Vratch, July 31, 1904, Abstract. New York and Philadelphia Medical Journal, September 17, 1904, page 565. Wounds of entrance and exit not given. Symptoms, intense shooting pain in legs and thighs, showing involvement of lumbar plexus. Operation, laparotomy five hours later. Course of bullet, through liver, stomach, lesser omentum, and pancreas. Bullet was not found. Treatment, wounds carefully closed with Lembert sutures (drainage not mentioned in abstract). Result, recovery.

CASE XVII.—CONNELL. (Case reported in this article.) Wound of entrance, below the fourth costal cartilage, right side. Wound of exit, absent. Symptoms, two hours after accident, pulse, 100; temperature, 99° F., and respiration, 20. Complained of intense colicky pains in the region of the umbilicus. Very restless; hæmatemesis. Operation, laparotomy three hours after injury. Course of bullet, through liver, through stomach at the lesser curvature, farther course not found. Treatment, suture of the stomach wound, and suture of the lesser omentum over the line of union. Liver wounds packed and then sutured. Abdomen closed without drainage. Result, death sixty hours after accident. Autopsy showed wound of the pancreas a little to the left of the middle; track of bullet through pancreas necrotic; site of suture of the stomach likewise necrotic; liver and abdominal wounds normal; no peritonitis.

CASE XVIII.—W. JEPSON. Personal communication. Wound of entrance, left fifth intercostal space, one and one-half inches from costal margin. Wound of exit, none, but bullet could be palpated above crest

of ilium at outer side of quadratus lumborum muscle. Symptoms, was seen by operator seven hours after accident. Shock not marked; child walked upstairs after the injury. Vomited blood and mucus; stomach was empty. Temperature, 97.4° F.; pulse, 108; respirations, 24. Pain not extreme. Operation, nine hours after receipt of injury. Incision in left linea semilunaris extending four inches from costal margin; this was joined by a transverse incision three inches long into the iliocostal space. Course of bullet, through diaphragm, anterior, superior, and posterior inferior walls of the stomach, mesocolon, and pancreas. It was thought that the duct of the latter organ was not injured. Treatment, diaphragm closed; both wounds of stomach closed by double purse-string sutures. Pancreas sutured with fine silk; drainage-tube fastened with catgut at site of pancreatic sutures; this tube was brought out posteriorly after incising the skin and dilating the track of the bullet; the tube was surrounded with gauze. The omentum was attached by catgut at the site of the suturing. The posterior gastric wound and the superior wound of the pancreas were provided for by a cigarette drain; after the peritoneal toilet was completed, this drain was brought out below the ribs at the outer border of the left quadratus lumborum muscle. The interior abdominal wound was closed without drainage. Result, recovery.

CASE XIX.—OTIS. Ibid. (Mikulicz, in his address before the American Congress of Physicians and Surgeons, mentions one case of recovery after operation for gunshot wound of the pancreas which he credits to Otis. After searching the literature on the subject, this is the only one that I have been able to find that might be the case. It is inserted last, as its belonging with the other cases might be rationally questioned. The case is as follows.) Wound of entrance, right side below ribs. Wound of exit, on the left side. Two days after injury, while straining at stool, a hernia of the pancreas, size of hen's egg, presented. No special symptoms supervened. Operation, silver wire passed around the pedicle, and tightened every day for a week, till it became very small, and was then snipped off with scissors. Result, left hospital in a month, and was still well two months after.

Since the above was written the following case has been noted.

CASE XX.—A. BECKER. (Zent. f. Chir., 1905, No. 5.) Wound of entrance, between eighth and ninth left costal cartilage. Wound of exit not mentioned. Operation, laparotomy, one hour after injury, disclosed a grazing wound of the stomach, without perforation into the lumen of this viscus. A large hole in the tail of the pancreas. The pleura was torn. Treatment, suture and gauze packing. Result, recovery, with pancreatic fistula, which finally closed.

In reviewing these cases there will be found 20 cases with 11 deaths and 9 recoveries; 6 cases not operated upon, 6 died. Considering No. XIX as a non-operative case leaves 7 non-

operative cases, with 6 deaths and 1 recovery, 12 operated cases with 5 deaths and 7 recoveries. In three of these 12 cases the injury of the pancreas was unsuspected or not found, all of which resulted fatally, leaving 9 cases operated for gunshot wound of the pancreas, of which 2 died and 7 recovered.

As to the operative procedure.

In 7 cases no operation was performed, of which 6 died and 1 recovered.

In 3 cases laparotomy was performed, but nothing was done to the pancreas; abdomen was not drained, 3 died.

Drainage of the pancreas, 4 times, 1 died and 3 recovered.

Suture of the pancreas, no drainage, in 1 case with 1 recovery; with drainage, 3 times, with 3 recoveries; with drainage not mentioned, 1 with a recovery.

As regards the other viscera injured there were:

Stomach, 8 times with 4 recoveries and 4 deaths.

Liver, 7 times with 3 recoveries and 4 deaths.

Lesser omentum, 4 times with 2 recoveries and 2 deaths.

(In two instances was the lesser omentum injured without injury to the stomach.)

Diaphragm, 3 times with 1 recovery and 2 deaths.

Spleen, 2 times with no recoveries and 2 deaths.

Small intestine, 2 times with 1 recovery and 1 death.

Large intestine, 2 times with 1 recovery and 1 death.

Lung, 1 time with no recoveries and 1 death.

Kidney, 1 time with no recoveries and 1 death.

Heart, 1 time with no recovery and 1 death.

Portal vein, 1 time with 1 recovery and no death.

Fat necrosis was noted on only two occasions at autopsy, and not at all at the time of the operation.

Death occurred at variable times after the receipt of the injury.

In the 6 non-operated cases, 30 days, 15 days, 12 days, 25 days, immediately, immediately.

In the 5 deaths following operation:

Operation 20 hours after the accident, with death occurring 33 hours after the injury; 2 hours after accident, death

38 hours after; 1½ hours after accident, death on the ninth day; 8 hours after accident, death a few hours later; 3 hours after accident, death 60 hours after.

In the 7 recoveries after operation, the operation was performed 9, 8, 1, unknown, 4½, 5, 9 hours after the injury.

The wound of entrance in 6 cases was in the posterior abdominal wall, and in the other 13 it was in the anterior wall.

A *résumé* of the symptoms in these 20 cases leads to the conclusion that there are no pathognomonic, or even suggestive, symptoms of injury of the pancreas in gunshot wounds of the abdomen. The probable course of the bullet is the chief guide. In wounds of the lesser omentum and the posterior wall of the stomach, especially, injury of the pancreas must be excluded before the abdomen is closed.

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# HYDROCELE IN THE FEMALE.[1]

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MRS. R. H., colored, forty-two years of age, was admitted to St. Luke's Hospital, October 31, 1904.

The family history was negative. The patient, besides the ordinary diseases of childhood, had suffered an attack of malaria six years previous, and of appendicitis one year later.

Her menstrual periods, until recently, were regular and accompanied by some pain. Of late the patient has had many uterine hæmorrhages, persisting from four days to a week, during which large clots of blood were passed. The patient has had three normal pregnancies.

The condition for which the patient sought admission to the hospital was a mass in the right inguinal region. This growth appeared eighteen years ago, subsequent to the birth of the second child. The patient stated that the mass had always been reducible, but that it would reappear in four or five days after reduction. Eight days previous to admission the mass would no longer disappear on pressure. The patient now became slightly constipated and nauseated. She had emesis twice. There were severe pain and marked tenderness in the region of the mass.

By physical examination, it was observed that the patient was well developed and fairly nourished. The expression was anxious and the tongue coated. The temperature was 99.6° F.; pulse, 88; and respiration, 28. The leucocyte count was 13,000. A few dry râles were heard over the entire chest. There was a faint systolic murmur over the apex of the heart. Vaginal examination revealed marked tenderness of the adnexæ; the uterus was enlarged and swollen, and there was a white vaginal secretion. The left tube was swollen, and there was a small hard nodule on the right side of the uterus.

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[1] Read before the Chicago Surgical Society, January 16, 1905.

Over the right inguinal region was a soft mass extending from the external abdominal ring into the right labium majus. It was slightly larger than an egg, was oblong in shape, being larger below than above, and was irreducible. It was tense, elastic, and very tender.

The patient was admitted on a diagnosis of strangulated hernia. That it was not a hernia was recognized after she was anæsthetized. An immediate operation was performed. An incision was made parallel to Poupart's ligament. The tumor was found to be separated from the skin by a tough, adherent fascia. This fascia was removed. The cystic tumor was opened and an ounce and a half of pale, straw-colored fluid removed. The sac was freed from the surrounding tissue, and from the round ligament with which it was intimately connected, ligated at its highest point, and removed. The layers of the abdominal wall were sutured as in a Bassini operation for inguinal hernia; the round ligament fastened in the inguinal canal by means of buried sutures. The skin incision was closed by silkworm-gut sutures in the usual way.

On the day following the operation, the patient was in fair condition. The temperature reached 100.2° F. The leucocyte count was 28,000. During the next few days the temperature dropped to normal and the leucocyte count fell to 12,000.

The anatomical diagnosis was "hydrocele of the canal of Nuck."

The cyst was bilocular, being divided by the internal abdominal ring into an upper and lower sac. The upper sac lay entirely within the peritoneal cavity. The round ligament entered this sac and became attached to its inner smooth surface. At the point of entrance was a small opening which allowed a free communication between the cyst and the peritoneal cavity. The lower sac was much larger than the upper and contained many incomplete septa, giving the appearance of a lymphangioma cysticum. The lower and upper sacs communicated through a narrow constriction at the internal abdominal ring. Near this constriction was found a bean-shaped body which lay free in the lower sac.

Microscopically the cyst wall was found to be composed of dense fibrous tissue. An endothelial lining could not be demonstrated in any of the sections examined. The sac contained a

homogeneous substance which stained faintly with eosin. There were no cellular elements in the contents, and there was no evidence of inflammation in the cyst proper.

The bean-shaped body which was removed from the lower sac was composed for the most part of fibrous tissue with spindle-shaped nuclei. There was a preponderance of extra-cellular substance arranged in wavy bundles. In a few areas were found groups of young mesoblastic cells. One portion of the tissue was infiltrated with red blood-cells and leucocytes, and in this area were also found numerous engorged blood-vessels with newly formed walls. This tissue bore all the evidences of a recent acute inflammatory process. The presence of blood-vessels in this loose body indicates that it was at one time attached to the wall of the hydrocele.

The relation between the history and the anatomical findings seems fairly clear. The ease of reduction previous to the last week was due to the fact that the fluid could be forced from the lower into the upper sac and into the peritoneal cavity. The reappearance of the tumor after a few days was due to the gradual return of the fluid into the lower sac. The sudden irreducibility was probably due to obstruction of the point of communication between the upper and lower sacs by the bean-shaped body found in the lower sac. It is difficult to explain the origin of this small body, but it would appear from its histological appearance to be of recent inflammatory origin. This view is supported by the clinical findings of acute pain and tenderness in the region of the hydrocele.

The terms Hydrocele in the female, Hydrocele of the canal of Nuck, Hydrocele Muliebris have been applied in a general way to all cysts in the inguinal region in the female.

The classification of these cysts as given by Rignoli seems to most completely describe the various anatomical conditions that may there exist. He divides all cases of Hydrocele Muliebris into five groups:

(1) Diffuse hydrocele or hydrocele of the cellular tissue about the round ligament.

(2) An accumulation of fluid in the canal of Nuck, communicating with the free peritoneal cavity.

(3) An accumulation of fluid in the vaginal process without a communication with the general peritoneal cavity, an encysted hydrocele.

(4) An encysted hydrocele in the connective tissue about the round ligament. A condition similar to group 1.

(5) An accumulation of fluid into the remains of an old hernial sac.

The existence of a true hydrocele of the canal of Nuck has been frequently disputed. French writers in general deny the existence of a true vaginal process of the peritoneum, and therefore do not admit of the possibility of a hydrocele in the female. The researches of Zuckerkandl, Niemann, Bergmann, and Sachs establish the existence of a vaginal process of peritoneum in the female.

Bergmann examined 158 female cadavers between the age of one month and three years, and found the canal patulous throughout in five and partially open in twelve. Sachs found it in thirty-seven out of 150, and Niemann in twenty-eight of forty-six that were examined.

Those who claim that it does not exist, base their opinions mostly upon the researches of Velpeau and Duplay. The latter examined twenty-one female embryos after the fifth month, and was unable to demonstrate a patulous canal in any.

Hydrocele in the female is of clinical importance because of its resemblance to an inguinal hernia. In most of the reported cases the true nature of the condition was recognized only when an operation was undertaken for the cure of the supposed hernia. In a few, as in our case, the symptoms of incarceration or of strangulation added to the objective signs of hernia and made the difficulty in diagnosis still greater. Thierhaber reported a case very like ours.

A woman aged forty-two years slowly developed a tumor in the inguinal region, which suddenly increased in size and became painful to touch. The tumor, the size of a goose-egg, filled the inguinal canal and projected below the external ring into the labium. It was dull on percussion, tense, and elastic on palpation. With the pain came obstipation, vomiting, and abdominal distress. The symptoms led to the diagnosis of an inflamed, partially obstructed hernia with excessive fluid in

the hernial sac. Operation revealed a bilocular hydrocele, one part within the abdominal cavity. The two chambers communicated, but did not open into the free peritoneal cavity. The contents of the sac was a turbid flocculent fluid. The sac showed evidences of an acute inflammatory process.

Three similar cases are reported by Chiari. In these infection with inflammation of the sac gave rise to symptoms of intestinal obstruction,—vomiting, abdominal distention, and obstipation. Operation revealed the nature of the condition. In these cases unsuccessful attempts had been made to reduce the supposed hernia. The danger of this procedure is apparent. Although the diagnosis of hernia has generally been made in the cases reported, yet, when the possibility of a hydrocele is kept in mind, the true character of the condition may be determined without operation. The presence of a tense, elastic, fluctuating swelling in the inguinal canal, or extending below the external ring that has developed slowly without any known cause, and that gives no impulse on coughing, will suggest hydrocele. Operation gives the only indubitable evidence of the presence of fluid in the sac. That a hydrocele and a hernia may coexist must also be borne in mind. In our opinion the safest diagnostic procedure is incision. This is also the most rational therapeutic measure to employ.

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# TUBERCULOSIS OF THE TESTICLE.[1]

EPIDIDYMECTOMY; GRAFTING OF THE VAS DEFERENS INTO THE GLOBUS MAJOR.

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In inviting your attention to tuberculosis of the testicle, I do so for two reasons, first, because a paper upon this subject has not been presented before this Society for the past five years or more,—and, as it is one of growing importance, I trust this imperfect presentation may not come amiss,—and, second, the emphasis given to the subject in my own mind by a case recently under my care, of which the following is the history.

Mr. G. A. E., aged twenty-seven years. Referred to me by the late Dr. Rundlett, January, 1904.

*Family History.*—Father died at forty-seven, from kidney trouble; had only one kidney. Mother living, sixty-three; tall, thin, nervous, anæmic. Sister, aged thirty-six years; same constitution as mother; has tuberculosis of one lung. Brother, aged thirty-eight years; same general type. In fair health.

*Previous History.*—Had a first attack of gonorrhœa in 1897. It was very severe. Acute inflammation lasted for two months; this was followed by left epididymitis of four weeks' duration. Recovery was gradual, but not complete for one year. In 1899 he was operated upon in the Philadelphia Polyclinic for a left varicocele caused by wearing a truss twelve years for hernia. Good recovery.

In 1900 a second attack of gonorrhœa occurred. This also was very severe, and was followed by a right epididymitis which lasted six weeks. Recovery was very slow and never complete.

In 1901 had a probable recurrence of gonorrhœa which was not severe. Cured apparently in six weeks. Epididymitis did not follow.

[1] Read before the New York Surgical Society, January 25, 1905.

In 1902 there was another slight attack of gonorrhœa. He was circumcised and operated upon for hernia with good recovery and satisfactory results.

In 1903 had a slight discharge from urethra, but this soon stopped. There remained, however, a slight gumming of the meatus and strings in the urine. He was treated by four different persons for seven months, and the condition was the same at the end of that time as at the beginning.

*Present History.*—January 31, 1904. Tall, thin, anæmic, narrow-chested man. No tubercular evidences anywhere except in the left testicle, in which the epididymis was hard and nodular. Neither the vas nor testicle itself were indurated. The nodule was tender to pressure but not very painful. The right testicle and epididymis were apparently normal. Rectal examination showed the prostate somewhat enlarged, smooth, and not sensitive. No enlargement of the seminal vesicles. Urination was a little more frequent than normal, and often there was burning in the urethra or at the neck of the bladder. The urine showed some mucus and strings floating through it, and by the microscope a moderate amount of pus, streptococci, but no gonococci or tubercle bacilli.

*Diagnosis.*—Tuberculosis of left testicle, probably confined to the epididymis.

*Treatment.*—Castration. Recovery satisfactory.

Microscopical examination of the specimen showed the nodules to be tubercular. The slight urethral discharge disappeared, and did not return until his marriage on May 10, 1904.

A painful, hard nodule appeared in the tail of the epididymis of the remaining testicle in April, 1904. This became worse after marriage. The urethral discharge became more free, so that half a drachm would run from the urethra on standing, after sitting, or lying. It was thin and whitish in color. The microscopical examination showed only streptococci. The disease in the right testicle spread slowly, the swelling and induration extending into the body of the epididymis and for two inches along the vas.

The patient was put upon supportive treatment, ichthyol ointment applied to the scrotum, and in June he was sent to the Maine woods. Soon after his arrival there the urethral discharge ceased, and the swelling and tenderness began to diminish in the testicle.

On September 12, 1904, Mr. E. returned to this city with his general health much improved. The local condition also showed decided improvement. The testicle itself and cord seemed normal, but there was a small, hard, and tender nodule about three-quarters of an inch in diameter in the globus minor. The nodule did not seem to be connected at all with the testicle proper.

On September 15, assisted by Dr. Pisek, after the usual antiseptic and preoperative preparations, this operation was performed.

The scrotum was anæsthetized by injecting a 1 per cent. solution of cocaine transversely near its perineoscrotal and inguinoscrotal junctions. The testicle and cord were exposed through a two-inch incision. The cord was fully infiltrated with this weak cocaine solution. The vas was isolated and severed opposite the globus major. The patient did not know when it was divided. The upper end of the vas was caught in the surrounding tissues with fine forceps, the lower end clamped. The globus minor and body of the epididymis were dissected free from the testicle to the globus major, severed between a clamp and ligature, and removed. No nodule could be felt in the testicle. An incision into the tunica albuginea showed apparently normal testicular structure. This incision was closed by fine catgut. Then the globus major was incised, and the end of the vas tucked into the small cut and fastened there by one stitch of No. 0 ten-day chromic catgut. No attempt was made to close up the opening in the tunica vaginalis, as a large part of it had been removed. The wound was dressed with a wick of catgut and closed by the same suture material.

A small artery evidently came to life after a few hours, and a considerable hæmatoma developed in the scrotum. This was early cleaned out, and the wound healed throughout, so that within two weeks the patient was out of doors.

Dr. Ewing's report on this specimen is as follows: "There are no definite signs of tuberculosis in any of the three portions of tissue examined. Stains for tubercle bacilli in the sections were also negative. In the main mass of the epididymis, however, some of the vessels show considerable numbers of round cells in their sheaths, and this may indicate an early stage of a tubercular process, but it is too slight to permit a diagnosis of tuberculosis."

As we know, however, that the other testicle was distinctly

tuberculous, and this one had every clinical symptom of the disease, there is no doubt in my mind that the process was a tubercular one, and that we were fortunate enough to remove it entire before the later tubercular changes had occurred. The report is especially valuable in confirming what is generally accepted at the present time, viz., that the beginning of the disease is in the blood-vessels, as infection is usually through them.

A month after the operation the patient reported that he was feeling fine. "Seem to have normal sexual power, and there is no pain in scrotum." Returned to the Maine woods for the winter.

November 2, 1904, I received the following report: "General health is excellent. Sexually I am all there, just the same as ever, not a particle of difference in any perceptible way." He wrote on December 11 that his "general health was good. He was strong, active, and had good sexual power. The testicle has greatly decreased in size and is now about as large as a walnut. There are no definite sore places anywhere, but occasionally an ache in the cord. There are no bladder or urethral symptoms." A specimen of semen was forwarded, in which, after being centrifuged, no spermatozoa were found. Consequently the anastomosis attempted failed in this patient.

That such an anastomosis with a patent canal is possible is proved by the result obtained in a case operated upon by Edward Martin (*New York Medical Journal*, October 10, 1903). His case was one of sterility due to double obliterative epididymitis. He grafted the vas into the tail of the epididymis. In spite of infection and suppuration, the operation succeeded, and, later, normal seminal fluid was obtained. Afterwards his wife became pregnant, and the girl baby born presented a striking resemblance to the father.

*Pathology.*—Tubercular disease of the testicle in the adult begins, as a rule, in the epididymis. Originating in the globus minor, it invades, by continuity of tissue, the body and globus major of the epididymis, then the vas and the testicle itself. In thirteen cases operated upon by J. B. Murphy (*Journal of the American Medical Association*, November 10, 17, 24, December 1 and 8, 1900) for genital tuberculosis, the disease

was limited to the epididymis, and the testicle not involved in any. In one case the cord and seminal vesicle were also involved. Orville Horwitz (*Journal of the American Medical Association*, June 21, 1902) found in ninety-six cases operated by himself that the disease was primary in the epididymis forty-eight times, in the testicle twenty-seven times, and in the remaining twenty-one cases in other regions than the epididymis or testicle. Von Büngner (*Beiträge für klinischen Chirurgie*, Band xxxv, Heft 1) finds the epididymis usually involved first, then the vas next, the testicle, the prostate, and seminal vesicles only very infrequently.

*Etiology.*—The path of infection is usually by way of the blood-vessels, and the arteries to the epididymis present, according to Saltzmann (quoted by Horwitz), an anatomical arrangement predisposing to the development of tuberculosis here, for the spermatic artery divides opposite the epididymis, and the vessels to that organ are smaller and more tortuous than those to the vas or testicle, and the blood-stream in the vessels of the epididymis is therefore slower. The condition plus some slight traumatism predisposes to the arrest of the tubercle bacilli at this point. Involvement by way of the lymphatics is very rare, but possible. Descending infection through the vas is not considered now to be as frequent a path of invasion as through the blood-vessels; but that it is possible, aside from the opinion of many writers, the experimental production of tuberculosis of the epididymis by Delli Santi (*Riforma Medica*, Vol. xix, No. 28, 1903) establishes this contention. He was able to produce tubercular epididymitis in the dog by injecting tubercle bacilli into the urethra. It was necessary, however, to produce a pathological condition by ligating the spermatic veins and produce venous stasis in the organ. The control animals not injured did not develop tuberculosis.

The predisposing factors may be briefly summarized as follows:

Age. About thirty, when the glands are most active.

Heredity. Possibly shown in those cases developing in infancy.

Traumatism. This, whether slight or severe, probably plays a very pronounced part in locating the disease in the epididymis, as already explained, by the normal arrangement of the blood-supply.

Previous gonorrhœa. Murphy attributes to gonorrhœal epididymitis or posterior urethritis the most important predisposing factor in the subsequent development of tuberculosis of the epididymis and testicle. Paul Thorndike (*Boston Medical and Surgical Journal*, July 3, 1902), in reporting seventy-five cases, found gonorrhœa to be an immediate cause in twenty-five. E. Haas (*Beiträge für klinischen Chirurgie*, Band xxx, Heft 2) assigns to gonorrhœa a causative action in only 5 per cent. of his cases.

The disease is usually unilateral, the right more frequently involved than the left. In only a very small proportion of cases (3½ per cent., Haas) is the disease bilateral, although, whichever testicle is involved first, the other is soon affected in 38 per cent. of cases (Haas).

The pathological changes in brief are but the repetition of tubercular processes elsewhere. The structures first involved are the intertubular connective tissues of the epididymis. The other structures are gradually implicated by the extension of the process by a continuity of tissue. Discrete tubercular nodules later become fused together. They remain such or undergo caseous degeneration, form an abscess which may remain encysted, burrow, or discharge externally by one or several sinuses. The vas, tunica vaginalis, mediastinum testis, the seminal vesicles, and prostate may become involved.

The progress of the disease is slow or rapid, depending upon the general health of the individual and the absence or presence of mixed infection.

*Signs and Symptoms.*—The signs and symptoms appear insidiously and progress slowly, unless there be very poor health and a mixed infection, when the onset may be sudden and the course rapid and violent.

The first symptom is usually a feeling of weight and discomfort in the testicle, some tenderness of the part affected,

seldom developing into pain until the disease has lasted quite a considerable time. The pain then felt is dull, aching; may extend up the cord to the groin or even be felt in the back. These sensations are usually intermittent, disappear on rest to return on exercise. The first sign of the disease is the appearance of a hard nodule at the lower part of the epididymis, usually of slow but progressive growth. This nodular induration later involves the entire epididymis, then the vas for a varying distance, and, lastly, the testicle itself. A small hydrocele may be present. A urethral discharge usually exists, varying in quantity and character; usually small in amount, thin and milky, but may be profuse, purulent, or bloody. This discharge promptly disappears after removal of the tuberculous nodule.

The vesical symptoms are usually late in appearing and are not urgent. There may be merely irritability of the bladder, marked by discomfort and burning attending the frequent micturition, or there may be severe pain, tenesmus, and even strangury. The more severe symptoms, however, do not appear when the disease is limited to the testicle. The urine rarely gives positive evidence of the disease. When tubercle bacilli are found in the urine the disease has passed far beyond the epididymis. Caution should be used in looking for the tubercle bacilli not to mistake the smegma bacillus for the one sought. Pus, blood, and mucus will usually be present in the urine, but these are not pathognomonic of the disease in question.

If the local lesion is not removed early the disease involves the entire epididymis, the nodules soften, break down, fluctuate, and the purulent contents may burrow into the tissues of the scrotum, or more often open spontaneously by one or more sinuses, which may discharge for months.

The general symptoms are those attending a tubercular process anywhere, and vary with the activity of the genital lesion, and whether there are other centres of infection, as consumption, hip disease, etc., or not.

The sexual function is usually preserved.

*Differential Diagnosis.*—Tuberculosis of the testicle has to be differentiated from simple infections, gonorrhœal or syphilitic inflammations, and benign or malignant growths of the organ. The time does not admit of a further consideration of these affections.

Horwitz advocates the use of tuberculin as a test for tuberculosis, and in doubtful cases it should be employed.

*Treatment.*—The formulation of the best course to be followed in a given disease is based partially on theory, but much more on practice. Theory is valuable, practice is essential to any correct conclusions. Therefore let us first review the results obtained by different operators with various methods.

E. Albert (*Therapie der Gegenwart*, January, 1900) denounces castration for tuberculosis of the epididymis. He restricts operative treatment to incision and evacuation of the nodules, and claims that castration is not required in tuberculous epididymitis, or else the disease has extended to the seminal vesicles and castration is useless.

L. Louguet (*Revue de Chirurgie*, January, 1900) advises early interference. He limits himself, however, to evacuating the abscess, curetting and cauterizing the cavity or searing it with very hot water. He claims that the "results surpass expectation in cases thus treated." He further states that castration is useless to check the spread of the disease.

In *Annales des Mal. Org. Gen.-Urin.*, Paris, June, 1902, Bodanowicz advocates the injection of camphorated naphthol in amounts varying from a few drops to one cubic centimetre. This proved efficacious in two cases out of six. The method is limited to those cases where pus is present. This is first aspirated and then the injection made. The method is too uncertain to be used when there are so many better ones.

Von Bruns (*Centralblatt für Chirurgie*, July 20, 1901) gives a summary of the results in 111 cases of castration for the past fifty years, performed at Tübingen; 46 per cent. of unilateral castration were cured from three to thirty-four years; 56 per cent. of bilateral castration were cured from

three to thirty years. One-half of *all* castrated patients were permanently cured. In all these cures the tubercular process was restricted to the genital organs. When the process involved the urinary system all have died.

P. Maŭclaire (*Press Medical*, September 22, 1900) treats genital tuberculosis by double ligature of the spermatic cord and excision of the included portion. The testicle soon establishes collateral circulation with the neighboring parts. The advantages claimed are the isolation of the tubercular focus and retention of the testicle for its physiological function in maintaining sexual power. He claims this method may prevent infection of the remaining testicle, which is not usually secured by castration.

Von Büngner (*Beiträge zur klinischen Chirurgie*, Band xxxv, Heft 1) claims continued success with his method of treating tuberculous testicles by avulsion of the vas high up through a high external incision for castration. He states that four-fifths of the vas can be thus removed. Horwitz condemns this procedure in vigorous terms as unsurgical and dangerous, and claims several serious hæmorrhages have followed the operation.

Von Büngner also advocates injection into the vas of a 10 per cent. solution of iodoform in glycerine, three to four grammes being injected upward and half this quantity downward. He has treated eighteen cases by his so-called method of "high castration" for tuberculosis restricted to the testicle and vas alone, supplementing this by the iodoform injection when he thought the entire tract was involved. As a last resort, he resected the entire tract, but this is very seldom necessary. He claims a total of 86.6 per cent. cures by his method, as contrasted with 46 per cent. of cures in unilateral and 56 per cent. in bilateral castration reported by Von Bruns; 66 per cent. of cures obtained by Simon in ninety-two cases, and 26 per cent. of cures in forty-five cases that Kocher treated.

The various methods—castration, avulsion, ligature and resection, incision and drainage—have their advocates. The

method of avulsion in connection with castration is too unsurgical and dangerous to be advocated. Incision and curetting are not a radical treatment for this disease in the early stage when cure is possible, although it may be useful as a palliative method later. Injection is of doubtful utility and a waste of time because it cannot by any possibility reach to and destroy all the diseased area, and postpones any other operation when delay is dangerous. Resection of the spermatic cord after double ligature, according to the statements of the originator, Maŭclaire, promises much, but its ultimate value is yet to be determined. A serious objection is that the diseased focus is not excised and remains as a menace to the individual. Castration is not followed by the brilliant results one would expect from so radial an operation. And it is especially objectionable where both testicles are involved, as impotency will follow. The psychological state dreaded by some writers after double castration seems not to have much basis in fact, and therefore does not play much of a part in our judgment as to the value or not of castration *per se*. But the loss of sexual function after double castration is sufficient in itself to cause most patients to put off the operation to such a distant time that no operation will be curative.

What have we then to offer our patients? Namely, this: A partial or complete epididymectomy with high resection of the vas, as first performed by Murphy in 1894; or epididymectomy with a grafting of the vas into the remaining portion of the epididymis, as attempted by Lilienthal in 1900 (personal communication), without, however, forming a patent canal, but with cure of the disease; or excision of the epididymis with a grafting of the vas into the rete testis or commencement of the coni vasculosi, as performed by Rasŭmowski in 1902 (*Archiv für klinische Chirurgie*, Band lxv, Hefte 3 and 4), who operated on four patients with retention of the sexual function.

Judging from the results obtained by Murphy (thirteen cases), Willy Meyer (ANNALS OF SURGERY, Vol. xxx, p. 649) (one case), Howard Lilienthal (personal communication)

(one case), and myself in the one here reported, the results from epididymectomy are more favorable than the best results obtained from castration, for in twenty epididymectomies there were only two deaths, one from probably tubercular kidney and the other from spinal disease. This gives 90 per cent. of cures. There was no extension of the disease in any of the cases to the portion of the testicle left behind, to the seminal vesicles, or to the prostate, and in only one to the kidney, and one to the spine, both of which died. In two cases of excision of the epididymis, in which the other testicle had been previously removed by castration, and in all cases where both epididymi had been removed at the same or different times (seven cases), the sexual function was preserved. While to the surgeon this fact may have small weight in influencing his choice of castration or epididymectomy, to the patient it is the one great argument that decides him in favor of an early operation, a curative procedure, and the retention of his manhood, as against a late and imperative castration of doubtful final utility, with loss of the sexual function.

The much-dreaded psychological state following double castration occurs so very infrequently that we can disregard this possibility entirely. If it has any weight, it certainly is on the side favoring the conservative procedure.

Whether we shall attempt an anastomosis or not between the vas and the remaining part of the epididymis or testicle is a question to be settled for each individual case. In spite of the failures in tubercular cases, such anastomosis has been successfully performed in one instance of double obliterating epididymitis from gonorrhœal origin (Martin, *New York Medical Journal*, October 10, 1903), and there is no especial reason why it should not succeed in tubercular disease limited to the epididymis with improved technique.

It will take several years and numerous operations to finally decide the question. At all events, we are fully justified in performing epididymectomy to castration in the usual form of tubercular testicle, and in attempting an anastomosis of the remaining portions of the vas and testicle, providing these parts are free from tubercular disease.

# RUPTURE OF THE TENDON OF THE BICEPS FLEXOR CUBITI.[1]

A CASE OF RUPTURE OF THE LONG TENDON IN ITS CONTINUITY, AND ONE OF RUPTURE OF THE SAME TENDON AT THE GLENOID ATTACHMENT; OPERATION WITH SUCCESSFUL RESULT IN EACH CASE.

**BY WILLIAM W. KEEN, M.D.,**

OF PHILADELPHIA,

Professor of Surgery in the Jefferson Medical College.

CASE I.—Dr. John B., aged fifty-four years, who regularly practises athletic exercises, first consulted me, December 16, 1904. His father and mother suffered from rheumatism and neuralgia. He himself had had muscular pains from time to time, but never a distinct attack either of articular or muscular rheumatism. He has had several attacks of diarrhœa. Five years ago had a severe attack of pleuropneumonia. When twenty years old was only five feet tall and weighed ninety pounds; at twenty-four his height was five feet two inches and he weighed 106 pounds. After his attack of pneumonia he weighed but eighty-five pounds. At present his height is five feet six inches and his weight 125 pounds. When a young man, his health was so poor that he was advised to go to Colorado. His persistent athletic practices are readily explained as a means he has adopted, and very successfully, to obtain robust health. Even in the very cold weather of this winter, I found that he only wore an open meshed undershirt.

In June, 1902, a pupil by accident let an Indian club slip, striking Dr. B.'s right shoulder on the anterior surface while the muscles were tense. No ecchymosis followed, but for six months abduction of the elbow was impossible, not from pain, but from muscular inability to lift the elbow. Twice since then he missed catching a hand-ball and fell forward, striking on his right shoulder.

On December 8, 1904, in a violent muscular effort to catch a hand-ball, he suddenly felt a pain about the junction of the upper and middle thirds of the right arm, so severe that he stooped

[1] Read before the Philadelphia Academy of Surgery, February 6, 1905.

and twisted his body to enable him to bear the pain. He noticed a lump on the arm, but paid little or no attention to it, as the pain quickly subsided. On December 13, he made a hand-spring, and again felt the pain at the same place.

On examination, December 16, I found that when he made forcible flexion of the forearm to a right angle and I resisted the flexion, the biceps' belly terminated at its upper portion suddenly, and I could not feel the tendon above that point. The upper end of the belly of the biceps also felt very flabby and soft, almost as if it were a hæmatoma, though not quite so soft.

My diagnosis was a rupture, more likely of the long head of the biceps. He had had but little pain, and his disability

FIG. 1.—The tortuousness of the tendon of the long head of the biceps.

FIG. 2.—Shows the fusiform swelling of the tendon below the bicipital groove and the mode of shortening the elongated tendon and suturing the two ends while held taut.

as a result of the accident both he and I estimated at about 25 per cent. The difference in outline of the two arms was more marked to the touch than to the eye, and hence I do not reproduce the photographs taken at the time.

In view of his athletic disposition, I advised and he accepted immediate operation.

*Operation*, December 18, 1904. I laid bare the biceps muscle and its upper tendons. The short head I found intact. The tendon of the long head lay tortuous like a snake (Fig. 1), extending from the body of the muscle upward. I had expected to find the tendon torn away from the belly of the muscle, but I found the two continuous. Traction on the tendon showed that

its attachment to the rim of the glenoid cavity was also firm. I dissected under the deltoid for a short distance upward till I reached the groove in the head of the humerus. About two centimetres below the groove began a fusiform swelling in the tendon extending downward about 1.5 centimetres (Fig. 2). This portion of the tendon was markedly discolored, almost black, evidently from blood effused within the sheath, but the sheath was intact. It was clear, therefore, that the tendon itself had been torn or ruptured within its sheath, and was much elongated, this partially destroying the function of the muscle. I severed the tendon just below the discolored portion, and, while each end was held taut overlapping the other about two centimetres, I sutured the two ends together with twenty-day chromicized catgut (Fig. 2). The arm was then placed on a rectangular splint so as to relax the biceps muscle. He went home, December 26, with the wound entirely healed.

January 26, 1905. He called to see me to-day. The splint was worn for two weeks after the operation, and the forearm was carried in a sling for two weeks more. At the end of that time he tells me he began doing athletic "stunts" with the arms, and has felt only the inconvenience which comes from weakness of the right biceps, due partially to non-use for a month. The muscular belly is quite flaccid as yet, and it is smaller than that on the right side by half a centimetre. The exercises he has taken have not been violent or prolonged, and presumably the biceps will improve very much in time.

[March 31. He is now practically as well as ever. The deformity of the biceps has almost disappeared.]

CASE II.—Dr. J. Chalmers Da Costa has kindly given me the following notes of his case: "In May, 1904, a man, aged fifty-two years, while lifting a heavy bucket or pail, was suddenly seized with violent pain in the upper arm. He dropped the bucket, and for several days kept his arm bandaged and in a sling. I first saw him several days after the accident. Flexion of the forearm could be slowly executed, but was feeble, painful, and incomplete. On attempting flexion, the short head of the biceps contracted and the belly of the muscle became abnormally prominent, but the muscular 'bunch' thus produced was flabby and nearer the elbow-joint than normal. An incision disclosed the long head of the biceps curved like a snake. When pulled upon,

it came entirely out of the bicipital groove. A portion of the periosteum had been torn off with the tendon, evidently from the margin of the glenoid cavity. A portion of the upper end of the tendon was cut off and the tendon was attached to the short head by splitting the latter and suture. Primary union followed. At present, nine months after the accident, the arm and forearm are strong and active. He uses the arm for all purposes of hard work without pain. The biceps actively flexes the forearm; the short head is much enlarged."

REMARKS.—Prior to the present cases there have been published only one case of operation for rupture of the belly of the biceps and one for rupture of the tendon.

Loos (*Beiträge zur klinischen Chirurgie*, 1900, Vol. xxix, p. 448) is in error when he states that Legueu operated. (See *Revue de Chirurgie*, 1895, Band xv, p. 897.) No operation was done by Legueu, and the cicatricial node in the tendon was not in the biceps, but the triceps tendon. The article of Loos just referred to and the earlier one by Maydl (*Deutsche Zeitschrift für Chirurgie*, 1882, Vol. xvii, pp. 306 and 513, and Vol. xviii, p. 35) covered most of the published cases up to 1900. These amounted to sixty-six in all.

I have not made further search of the literature than through my own card catalogue. This shows that there should be added to Loos's list the four cases reported by G. G. Davis (*Medical News*, 1895, Vol. lxvii, p. 121), Da Costa's, and my own cases herewith reported. These make a total of seventy-two cases. Loos states (p. 430, foot-note) that Petit has collected eighty-three cases of rupture, but that the paper had not been published in 1900, nor have I found it since.

It is a matter of surprise that a tendon should rupture in its continuity rather than that the muscular belly should yield or the tendon be torn loose from the muscular belly at the point of transition from the one to the other, or from the bony attachment of the tendon. There is, however, no doubt, as in my case, that this does occur.

I think Davis is, however, probably right when he says "the tensile strength of healthy tendon is so great that it is

my belief that true rupture is much rarer than is usually supposed, and that when a tendon does rupture, it is very likely to have been diseased." Yet, on the other hand, in a number of cases no prior disease was known. In the present case, in view of his prior history and later athletic life, there may or may not have been disease of the tendon.

Rupture of the biceps may take place at several points:

(1) In the belly of the muscle,

(*a*) Either that portion belonging to the long head;

(*b*) That belonging to the short head, or,

(*c*) The belly after union of these two portions.

(2) At the transition point between the muscular belly and one of the upper tendons.

(3) The transition point between the belly and the lower tendon.

(4) In the continuity of the tendon of the long head.

(5) At the point of insertion of this tendon to the rim of the glenoid cavity, or at least within the capsular ligament.

In some cases it is not easy to make an exact differentiation of the site of the rupture, hence all tables are to some extent unreliable. It is to be noted that *only in the operative cases has the exact* condition been verified by sight.

The combined cases of Loos, Davis, and this paper give for rupture of the muscle itself fifty cases as against twenty-two in the tendons, but of fifty-six cases in Loos's paper with more detailed histories to which Davis's four cases and these two are added, making sixty-two in all, there were forty-one of the muscle and twenty-one of the tendon. But from these twenty-one of rupture of the tendon six should be deducted as being at the point of junction of the tendon and the belly and the case of Legueu, which should not have been included. This leaves only fourteen cases of rupture of the tendon. The belly of the short head was only involved in two cases, and both of these were due to direct injury,—one in a threshing-machine, in which the tendon of the long head was also involved, and the other in an attempt at reducing a luxation of the shoulder.

In the larger series of Petit, the proportion is given as follows:

Rupture of the whole muscle, 21; of the long head, 9; at the transition point between belly and tendon, 7; of the lower tendon, 3; of the tendon of the long head, 43.

I think that there must have been some error in transcribing, for it would be extraordinary to have forty-three cases of rupture of the tendon of the long head and only nine of the muscular part of the long head. As stated, Petit's paper has not yet been published.

Besides the case here reported, there are only six cases of stretching or partial rupture of the long head similar to the present cases. Of all the cases reported by Loos, only four of rupture of the muscle and one of the tendon were caused, as in the present care, by muscular effort alone.

Of all the reported cases only two occurred in women.

The symptoms of rupture differ in rupture of the belly of the muscle and of the tendon. The muscular belly, either the whole of it, or (if the rupture involve, for instance, only the belly of the long head) a part or the whole muscle, becomes softened and loses its elasticity. Sometimes, in rupture of the belly into an upper and lower portion, there will be two tumors formed by the contraction of the two portions of the belly of the muscle, with a marked furrow between them from one to two fingers'-breadths wide. At the bottom of this furrow, sometimes even the bone can be felt. If the rupture is at the junction of the tendon with the belly, this double tumor, of course, will not exist, but there will only be a tumor of the belly and none of the tendon. If the rupture be of the belly of the long head, the muscular belly of the biceps will be drawn towards the elbow. If the rupture be at the lower end of the belly of the muscle, the whole muscle will be drawn up nearer the shoulder.

In an excellent paper by White (*American Journal of the Medical Sciences*, January, 1884, p. 17), on dislocations of the long tendon of the biceps, the differential diagnosis between that lesion and rupture of the long head of the muscle is well

stated; and one other point of importance is mentioned, namely, that in rupture, the head of the humerus, not being held down by the long tendon, is approximated more closely to the acromion, and the shape of the shoulder correspondingly altered.

When the long tendon is ruptured completely or partially, the symptoms are less pronounced, partly because only a portion of the muscle is involved and partly because the sheath of the tendon to some extent replaces the tendon. Of course, there is much less ecchymosis and the discoloration is not pronounced. Only the portion of the muscle corresponding to the long head is flabby and has lost its tone, so that it feels like a cyst or a hæmatoma.

Unfortunately, in my case, I did not observe whether Hüter's symptom was present. He called attention to the fact that flexion of the forearm in supination when the biceps is relaxed is much less forcible than when the hand is in pronation, and the biceps is more tense and can contract to greater advantage.

*Treatment.*—The treatment in almost all cases has been either none at all, where patients have neglected to seek the surgeon till long after the accident, or by means of a bandage with or without a splint, massage, and electricity. I mention the latter only to condemn it save in the *later stages*, after the rupture is healed. Then it will do much good in restoring the functional activity of the muscle. Earlier than this it would but separate the two portions instead of approximating them.

In a few cases good functional results have been obtained, for it is possible sometimes, by manipulation and bandaging, to approximate the two parts of the muscle if the rupture be in the muscle, so that union will take place by fibrous tissue with but little loss of function. If the rupture be confined to one portion of the muscle, of course the chances of restoration of function are much better than when the whole of the muscle is involved. Yet, often in the cases of only partial rupture, loss of function is very marked. This is not only

due to the separation of the ends of the muscle or of the tendon and the lengthening of the muscle by the length of the scar tissue which fills the gap, but also from wasting of the muscle, from interference with its innervation.

It is strange that surgeons have so rarely operated. The cases in which operations have been done thus far are as follows:

1. Von Hochstetter (*Wien. med. Woch.*, 1890, p. 399). A very muscular man of forty-six years. Over two months after the injury, the upper end of the belly of the muscle and the tendon which had been torn loose from the belly were united with silk. After four months complete ability to work returned.

2. Bazy (*Bull. Soc. de Chirurgie*, 1895, p. 156). A man, aged forty years, in whom there was a complete rupture of the tendon of the long head within the joint or even detachment of the tendon from the glenoid cavity as a result of lifting a sack weighing eighty kilogrammes. The tendon was reflected upon itself so that the torn upper end was turned downward. Bazy resected the tendon and united the stump to the tendon of the short head and the coraco-brachial. The arm was placed in plaster at a right angle. After one month there was complete restoration of function.

3. In my own case, the patient at the end of a month resumed, to a moderate degree, his athletic occupation and is now quite himself again.

4. The case of Dr. J. Chalmers Da Costa. The lesion and the operation were identical with Bazy's case. The result was very satisfactory, entire use of the arm having been regained.

The most encouraging results from these four cases of operative interference and the poor result in many others not so treated, it seems to me, should lead to operative treatment of cases of rupture rather than to trust to the more or less uncertain results of the treatment by bandages and splints.

# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY.

*Stated Meeting, January 11, 1905.*

The President, HOWARD LILIENTHAL, M.D., in the Chair.

## CALCULUS IN URETER; PERINEPHRIC ABSCESS.

DR. HOWARD LILIENTHAL presented a boy of twelve years, who was admitted to the medical service of Mt. Sinai Hospital on October 3, 1904. The diagnoses which were considered in his case were, first, typhoid fever, complicated by appendicitis; second, appendicitis alone; third, meningitis, complicated by appendicitis. His illness was of sudden onset, with high fever and rapid pulse. There was a leucocytosis of 20,000; no enlargement of the spleen; no eruption; no Ehrlich; no Widal. The fever was continuous, with only very slight remissions. There was an absence of the definite local signs of appendicitis.

A week after the boy's admission, the abdominal tenderness became localized in the right side, and there was acute sensitiveness in the right axillary line, below the third rib. When Dr. Lilienthal first saw him at this time, he noted the tenderness in the region of the appendix, but, on account of the large area over which it extended, the doubt as to diagnosis, and the absence of urgent symptoms, he advised against immediate operation, and suggested that the patient be poulticed and watched. This was done. The temperature continued to run up to 105.5° F. and the boy became much emaciated. Finally, he began to complain of pain in the right loin. Before that time, the possibility of a calculus in the ureter had been suggested, and this belief was subsequently strengthened by the presence of a few pus and red blood-cells in the urine.

The pain in the lumbar region persisted, and gradually very slight, deep doughy fluctuation could be made out in that area. On October 11, at Dr. Lilienthal's request, Dr. Elsberg made an incision over the right loin and found pus in the subphrenic region. A few days later there was a urinous discharge from the wound. Following this operation, the boy's temperature dropped, and he remained in good condition for a number of days. Then the temperature went up as high as before, and a nephrotomy was decided on, which was done by Dr. Lilienthal on November 16. A soft bougie was first inserted into the sinus, and then the kidney was cut down upon. The organ was very large and hard. It showed no evidences of suppuration, but there was evidently a collection of pus involving the perinephric tissues. Upon following down the ureter, he came upon the soft bougie, which had entered an old perforation of the ureter about two and one-half inches below the pelvis of the kidney. In spite of repeated efforts, the soft bougie could not be pushed down into the bladder, nor could colored fluids, introduced from above, be forced through the apparently occluded ureter.

The kidney was then incised and a finger introduced into its pelvis. No stone nor other abnormality could be discovered, nor could any calculus be detected in the ureter by instruments introduced from above. On account of the age of the patient, ureteral catheterization through the bladder was not attempted.

Several days after the operation, Dr. Lilienthal said he again attempted to force blue-colored fluid through the ureter from above, and about half an hour later a small quantity of greenish-tinged urine was passed. From this time on the boy's urine became very muddy, containing large quantities of mucus and pus, with some blood and casts. Several X-ray pictures, in different positions, were taken by Dr. A. G. Foord, assistant radiographist to the hospital, with the greatest care, but no stone could be detected. The kidney was flushed out daily by means of the injection of large quantities of water. The wound healed nicely, and on December 26 the boy was allowed to go home, with instructions to always urinate through several layers of gauze, so that in case a calculus was passed it would be detected. At this time the patient's condition was still unfavorable, and every four or five days he would have a sudden elevation of temperature. Three days ago his attending physician sent word that the cal-

culus had passed spontaneously, but that unfortunately it had been lost. With the expulsion of the stone, all the boy's symptoms disappeared, and the urine became clear.

Dr. Lilienthal said he believed that a radical operation for the removal of the stone in the ureter in this case might have resulted fatally. The patient's condition at the time was very poor, and such an operation would have necessitated a very long incision and a careful dissection. In the majority of cases of ureteral calculus, the speaker thought it was just as well not to operate, unless the X-ray showed the stone to be of such a size that its spontaneous expulsion seemed improbable.

In reply to a question as to the origin of the hole in the ureter, Dr. Lilienthal said it evidently must have resulted from an infection from the scraping of the stone. In reply to a question by Dr. Whitman, the speaker said that the limb on the affected side was not held in a flexed position. The so-called Meltzer sign—increased pain on hyperextension of the leg—was present.

## CERVICAL RIB.

Dr. Lilienthal presented a woman who had been referred to him by Dr. Manges. About a year ago she began to complain of pain in the left shoulder and neck. This pain was cramp-like in character, and radiated down the left arm to the finger-tips. She suffered at times from palpitation of the heart, the attacks being especially severe after the pain. She also complained of occasional difficulty in swallowing, of headache, and of a girdle-like sensation about the throat.

On examination, nothing was found but a tumor in the neck, which was easily recognized as a cervical rib. On deep inspiration, the left pulse was completely obliterated. There was a bruit over the left subclavian artery, which ceased on deep respiration, and reappeared, with increased loudness, after holding the breath. The neck was tender on palpation.

On account of the patient's symptoms, an operation for the removal of the supernumerary rib was determined on, and it was done after an X-ray picture of the condition had been taken. Upon deciding in favor of an anterior operation, an incision was made directly over the rib between the fibres of the sternomastoid muscle. The soft parts were then pushed up as far as possible towards the cervical vertebra, with which the rib articulated pos-

teriorly. He then cut through the rib with the bone forceps, and twisted off its upper or posterior section. Anteriorly, it was found to be firmly attached by osseous union to the first rib, and, as all embarrassment to the circulation had been apparently relieved, no attempt was made to chisel off the anterior section of the bone. The rib was removed to the level of the rather high arch of the subclavian artery. Further dissection would have been attended by great danger. A large part of the scalenus muscle had a tendinous attachment to the rib.

Immediately after the operation, the tingling sensations in the left hand were slightly increased, but the pulse remained absolutely normal. Within the past few days, however, it had become intermittent, and was completely obliterated on deep inspiration. This Dr. Lilienthal attributed to the firm cicatrix resulting from the operation, and he thought the symptom would disappear permanently in time with the atrophy of the scar. A supernumerary rib also was present on the right side, but it was much smaller and gave no symptoms.

Dr. Irving S. Haynes said he thought this condition of cervical rib was comparatively rare, as he could not recall more than a single instance of it during a long experience in the dissecting-room.

Dr. George E. Brewer mentioned a case in which this abnormality gave rise to severe pain over the distribution of the brachial plexus on one side, which was relieved by removal of the rib. In this case the patient was for a time thought to be suffering from a malignant new growth.

Dr. Brewer said he had recently had the opportunity of looking over Professor Dwight's very beautiful collection of abnormalities of the ribs in the Anatomical Museum at Harvard University. This included many specimens of cervical and lumbar ribs, and asymmetries on both sides of the thorax.

Dr. Otto G. T. Kiliani said he did not think this condition was very uncommon. In a case that recently was under his observation, the patient had a carcinoma of the stomach, and, because of difficulty in swallowing, it was also thought that he had a cancer of the œsophagus. Upon investigation, it was found that the dysphagia was due to a spasm of the œsophagus produced by a right-sided cervical rib.

Dr. Lilienthal, in closing, said he had seen several cases

in which this abnormality existed, and he did not think it was very rare; but it was decidedly uncommon to see cases in which these supernumerary ribs gave rise to any symptoms. In the case he had shown, the symptoms had only been present a few months, and the speaker thought it was strange that they did not come on earlier in life. The symptom of spasm of the œsophagus to which Dr. Kiliani referred had also been present to some extent.

## SPASMODIC TORTICOLLIS TREATED BY RESECTION OF NERVES.

Dr. Royal Whitman presented a woman, forty years old, who entered the Hospital for Ruptured and Crippled last summer with the history of having had spasmodic torticollis for the previous eight weeks. She had suffered a good deal of pain, and at frequent intervals the head would be drawn over to one side, the chin being tilted upward and turned in the opposite direction. On account of the short duration of the affection, it was decided to first try a resection of the spinal accessory nerve, and early last August about three-quarters of an inch of the nerve was removed at a point anterior to the sternomastoid muscle. This gave only partial relief, for, although the sternomastoid no longer participated in the spasm, the contraction of the posterior group was so strong that it was found impossible to control the movements of the head with apparatus. Four weeks later the posterior branches of the second and third cervical nerves were divided, and, as an additional precaution, the attachments of the muscles were separated from the occiput. Towards the end of the operation the vertebral artery was apparently wounded, and the violent hæmorrhage necessitated packing the wound.

Since the second operation the patient had been entirely relieved. There is no noticeable interference with the normal movements of the head, no difficulty in raising the shoulder, as is sometimes noticed after division of the spinal accessory nerve. The patient has been at work for several months.

Dr. Whitman thought his success in relieving the torticollis in this case was due to the fact that the operation was done early, before the spasm habit had been acquired.

Dr. Lilienthal asked Dr. Whitman how he explained the absence of shoulder paralysis in this case. The speaker said he

thought that disability always followed when the spinal accessory was cut so high up.

Dr. Whitman said there had been some weakness of the shoulder following the operation, but it had disappeared, probably through the aid of other muscles.

Dr. Charles L. Gibson asked Dr. Whitman whether he expected the cure to be permanent. He recalled a number of cases in which recurrences had taken place after different and sometimes very radical operations. In one case where he resected the spinal accessory and both branches of the third and fourth cervical nerves, and finally divided the sternomastoid muscle itself, there was a prompt recurrence of the spasm.

Dr. Charles H. Peck inquired as to the ultimate outcome of these cases when they were left undisturbed. He mentioned a case of quite severe spasmodic torticollis in which resection of the spinal accessory was done ten years ago. There was slight improvement after the operation, and the patient subsequently submitted to various forms of treatment with indifferent success. Finally, after about two years, the spasm gradually disappeared of its own accord. Very recently the patient had expressed the fear that the twitching was beginning again.

Dr. George E. Brewer said that in one case where he had cut the spinal accessory nerve there was temporary improvement. He then cut the sternocleidomastoid muscle, and again there was temporary improvement. In another case he divided the spinal accessory and the second, third, and possibly the fourth cervical nerves, in addition to cutting the muscle. The patient was entirely relieved for a time, but the spasm soon returned. It sometimes happened, Dr. Brewer said, that, with an anomalous distribution of the spinal accessory, only part of the sternomastoid was affected by its division. Dr. M. Allen Starr had made the suggestion that in some cases the lesion in spasmodic torticollis was cortical, although that theory could not be proven.

Dr. Kiliani mentioned a severe case of spasmodic torticollis in which he resected the second, third, and fourth cervical nerves. In spite of this, the patient's head was still drawn to the right, although the spasm had ceased. From this case he had gained the impression that the innervation of these muscles was sometimes anomalous.

Dr. Lilienthal thought that, if the lesion in these cases was

a cortical one, resection of the cervical nerves ought to control the spasm. He suggested that lengthening the muscle by a plastic operation might have a beneficial effect. If the muscle could be lengthened to such a degree as to well over-correct the spasm, the deformity would not be so pronounced.

Dr. Whitman, in closing, said that he was surprised to learn that the prognosis was thought to be so bad after operation for this condition. Richardson and Walton, of Boston, who had reported by far the largest number of operations, found lasting benefit resulting in a majority of their cases. In reply to Dr. Peck, the speaker said that the ultimate outcome of this condition, if left undisturbed, was not extremely unfavorable, since spontaneous recovery was not unusual after several years; but in the meantime the patients suffered a good deal of pain and discomfort both physical and mental, and were practically incapacitated. He did not think that much could be accomplished by overstretching the muscles or by plastic work. There were too many muscles in this collection to lengthen them all. While neurologists knew nothing positive about the etiology of spasmodic torticollis, they usually looked upon it as a cortical lesion. After the condition had existed for a number of years, the affected muscles became hypertrophied and permanently shortened. The mental and moral effect of such a noticeable and disabling affection must also make the operative diagnosis worse in cases of this class.

SMALL, ROUND-CELLED SARCOMA OF THE BACK SUCCESSFULLY TREATED BY THE X-RAY COMBINED WITH THE MIXED TOXINS OF ERYSIPELAS AND BACILLUS PRODIGIOSUS.

Dr. William B. Coley presented a boy of eleven years, whose family history was good. In the latter part of August, 1901, he fell from a stoop, striking on his back. Two or three weeks later his mother noticed a swelling in the midscapular region, a little to the left of the median line. This swelling increased very rapidly, and was soft and fluctuating from the beginning. The patient was referred to Dr. Coley on December 23, 1901, by Dr. Polhemus, of Nyack, New York.

Physical examination showed a cystic swelling, the size of an orange, in the left scapular region. The skin was normal. The tumor was fluctuating, and situated, apparently, beneath the skin

and superficial fascia. A diagnosis of hæmatoma was made, and on January 12, 1902, an incision was made under ether anæsthesia. Several ounces of dark blood were evacuated. There was no evidence of any solid tumor at this time. The wound was closed without drainage, and healed by primary union. About three weeks later a tumor began to develop at the original site. This was also cystic in character, and increased rapidly in size until May 6, when it had become one-third larger than that previously operated upon. It was again incised under ether, and at this time, in addition to fluid blood and clots, there was such a thickening of the walls of the cyst that it raised a suspicion of sarcoma. A portion of this thickened tissue was removed and examined by Dr. H. T. Brooks, Professor of Pathology at the Post-Graduate Hospital, who pronounced it a small, round-celled sarcoma of high vascularity.

Two weeks after the operation, and before the wound had entirely healed, the X-ray treatment was begun, and continued, three times weekly, during the entire summer and fall of 1902. In December of the same year there was still marked evidence of local recurrence in and about the cicatrix. The tumor continued to increase in size in spite of X-ray treatment. On January 26, 1903, Dr. Coley operated for the third time, and removed the recurrent tumor, together with the old cicatrix. The wound healed by primary union. Shortly after the patient left the hospital, the X-ray treatments were resumed, and continued once or twice weekly during all of 1903 and the first half of 1904. In June of that year signs of another recurrence were noted in the old cicatrix, and at this time, in addition to the X-ray treatment, he began the injections of the mixed toxins of erysipelas and Bacillus prodigiosus in the vicinity of the scar. The injections were continued from July 4 up to the present time, a period of about six months, in addition to two X-ray treatments weekly. Under this combined treatment, the recurrence slowly disappeared, and the ulcerated area healed over. At the present time there was no trace of a growth visible anywhere. The boy's general health had always remained perfect.

## SARCOMA OF THE FEMUR.

Dr. Coley presented a man, nineteen years old, who first noticed a swelling in the lower portion of the left femur in Novem-

ber, 1901. This gradually increased in size, and was accompanied by loss of weight and deterioration of general health. The patient came under Dr. Coley's observation February 5, 1902. At that time physical examination showed a large tumor extending from the condyles of the left femur to the junction of the middle and upper thirds. The tumor consisted of a fusiform enlargement of the entire lower two-thirds of the femur; on the outer aspect of the thigh, about one and one-half inches above the joint, there was a soft, fluctuating area, just covered by thin and reddened skin. There was also impairment of the functions of the joint, but no swelling of the joint itself. An incision was made under cocaine into the fluctuating area, and three ounces of clear serum, similar to that which is found in cystic degeneration of sarcomatous tissue, was evacuated. The curette passed into the cavity of the bone, and typical sarcomatous tissue was removed. Microscopic examination by Dr. E. K. Dunham showed it to be round-celled sarcoma. *The patient absolutely refused operation, although he was told that this was the only thing that offered any hope of saving his life.* The X-ray treatment was tried entirely as an experiment, with the result that the tumor decreased one inch in circumference. After a month's treatment the exposures were discontinued for two weeks, at the end of which time the tumor had increased nearly an inch in size. The treatment was again resumed and the growth slowly decreased in size, until at the end of another month the circumference of the thigh over the centre of the tumor was one inch less than the original measurement. The treatment was continued four times a week up to September 30, 1902, when the leg was nearly normal in size and the patient had gained twenty pounds.

In December, 1902, a metastatic tumor developed in the left pectoral region. This grew rapidly, until it had reached the size of a hand, and was then partially removed under ether anæsthesia. It was found to be very soft and highly vascular. Shortly after this, a large tumor, the size of a child's head, developed in the right iliac fossa, extending from the costal cartilages down to the pelvis. It could be easily felt in the lumbar region. At this time, in addition to the local treatment with the X-rays in the femoral and pectoral regions, injections with the mixed toxins of erysipelas and Bacillus prodigiosus were begun. After a few weeks the large tumor in the iliolumbar region began to soften and break

down, and when it had become completely fluctuating, it was opened posteriorly. A very large quantity of necrotic tumor tissue was evacuated, and the wound was drained for about a year. While the tumor in the leg had apparently disappeared, there remained a marked thickening of the bone, and the sinuses leading to the broken-down areas persisted. Examinations of several curettings failed to show any evidence of sarcoma. At the present time, aside from the sinus in the leg, the boy appeared to be in perfect health, and there was no evidence of sarcoma to be found anywhere.

In view of the fact that periosteal round-celled sarcoma was probably the most malignant of all varieties, running its entire course in from one to two years if left untreated, and usually recurring and proving fatal within a year after hip-joint amputation, the result in this case, whether it proved curative or not, was extremely interesting. Dr. Coley said that in all of the six cases in which he had performed hip-joint amputation, recurrence took place within a year, and death within eighteen months.

Dr. Lilienthal said he was using the mixed toxins of erysipelas and Bacillus prodigiosus in all his inoperable cases of sarcoma, and also in those cases where he had the slightest suspicion that some of the malignant tissue was left behind after operation. He had seen some rather remarkable results following the use of the toxins. In one case of partial extirpation of a pigmented, cystic, giant-celled sarcoma of the rib and involving the costal pleura, the patient had remained well up to the present time, a period of over two years. In that case a prompt recurrence was confidently expected, and that it did not take place was apparently due to the use of the toxins.

Dr. Coley, in reply to a question, said he had seen deep-seated malignant tumors disappear under the use of the X-rays alone, but in every single instance there had been a recurrence within six months.

## DISINFECTION OF THE SKIN.

Dr. Robert H. M. Dawbarn read a paper upon the above subject.

Dr. Lilienthal said he thought that rubber gloves should be first filled with water and then boiled. Any bacteria that were

not killed by boiling in plain water could be destroyed by boiling in soda solution. The speaker said that, while he thought the gloves should be worn for every operation, there were certain examinations in which they undoubtedly impaired the delicate touch of the uncovered finger. As an example of this, he cited the case where a cotton swab had been left in the female bladder. In searching for this the naked finger was used for obvious reasons. In connection with the closure of wounds, Dr. Lilienthal called attention to the value of zinc plaster wherever that method was feasible.

DR. BREWER said that the question of the infection of wounds from bacteria of the skin had come up for discussion at the meeting of the American Surgical Association in St. Louis last summer, and Dr. Harrington, of Harvard University, had made the assertion that his experiments had shown that the sweat bacteria were much less dangerous than they were formerly thought to be.

Dr. Brewer said he was strongly in favor of the use of rubber gloves. At Roosevelt Hospital they still employed the simpler methods of hand disinfection, using for that purpose bichloride solution, and sometimes the lime and soda. For the gloves themselves they used sterilized starch and talcum powder. The infection of wounds was such a complex question, and depended on so many factors, that it could not be solved by merely wearing gloves. One of the most important factors was the preliminary cleansing of the skin. Dr. Mayo had recently expressed the view that there was a certain tolerance of the skin for the micrococci that lived there, and that this tolerance was diminished by irritating the skin. In accordance with that view, he had adopted the plan of irritating the skin as little as possible. Instead of using a stiff brush, as they formerly did at Roosevelt Hospital, and applying various irritating applications, they now usually limited themselves to the use of a soap solution applied with a piece of gauze, and this method had been followed by a decided reduction in the number of cases of wound infection. During the past six months they had not had a single case of infection in a clean wound; previous to that, the longest period of immunity had been four months.

DR. DAWBARN said that boiling rubber gloves in soda solution, as just suggested by a member, would cause them to rot. One of the objections he had to using surgeons' plaster in the

closing of wounds, as suggested by the President, was that the plaster was not transparent, and infection might occur underneath it, even if in narrow strips, without being observed. He entirely agreed with Dr. Brewer that the methods resorted to to render the skin and hands aseptic should be simplified as much as possible; and it was with that object in view that he had written his paper. Upon reflection, it will be seen that neither in time nor work is the preparation of the hands increased; the certainty of asepsis is greater, and the irritation of the skin is less by the plan advocated to-night. He did not favor the use of starch and talcum in the rubber gloves as used at Roosevelt Hospital, because those powders did not dissolve in water or serum, and so, if entering a wound unobserved, through a small cut, remained as mechanical irritants. Dr. Brewer's excellent results quoted, as to asepsis, were not due to the Roosevelt methods, but to avoidance of wounding gloves. The personal equation was an important factor in considering the poisonous qualities of the sweat: that of some persons was very toxic, while that of others was comparatively innocuous. That the danger of infection increased with the irritation of the skin, whether that of surgeon or that of patient during preparation for operation, was a self-evident fact. Even reddening the skin should be avoided. When a chemical strong enough to blister was applied to the skin, infection almost invariably followed. Irritation, likewise, from undue pressure upon the skin by buttons or plates used with retention sutures, would regularly invite suppuration at these points, by stirring up a hornet's-nest activity of the microbic dwellers just beneath, deep in the skin. This was a particularly common mistake of inexperienced operators.

## FOREIGN BODY IN THE KNEE-JOINT.

Dr. Robert H. M. Dawbarn exhibited a radiograph, obtained from a child six years old, that was brought to him with a history of increasing pain with slight swelling in the left knee-joint for the previous five days. There was no history nor local evidence pointing towards any wound or trauma. But the day before being brought to Dr. Dawbarn, a slight chill was observed. As a matter of suspicion only, the child was sent to Dr. Milton Franklin, who first with the fluoroscope and then with the accom-

panying radiograph (Fig. 1) absolutely demonstrated the presence of a foreign body (needle) in the joint. It was removed without special difficulty, and the joint being then flushed first with 1 to 2000 warm bichloride solution, then with normal salt solution. The result was absolutely perfect, not even any stiffness of the joint remaining.

## RESULT OF OPERATION TEN YEARS AGO FOR MORTON'S METATARSALGIA.

DR. DAWBARN presented a radiograph showing the result after ten years of a resection of the head of the fourth metatarsal bone done for the relief of metatarsalgia (Fig. 2). The operation, the speaker said, was not followed by any deformity, and immediately and permanently cured the pain. It consisted in removing the head and neck of one of the two metatarsal bones that were in contact so as to nip the nerve occasionally between their spurs. The "ring-toe" (fourth) was the one most frequently so treated; but the nerve in any of the four spaces may be involved, and sometimes more than one. The late Dr. Morton's favorite operation for this condition was to cut out the entire joint; but Dr. Dawbarn said he did not see the necessity for such an extensive procedure. Another method used by some was to amputate the toe, together with the joint and its metatarsal head and neck; and, finally, some operators have searched for and excised a piece of the nerve in question. This last plan is by no means easy. If attempted, the incision must be on the dorsal surface. No cut should be made on the plantar surface, so as not to leave a scar upon which pressure would be exerted in walking. The pain suffered by these patients was often agonizing, and was chiefly complained of after the shoes were taken off.

DR. WHITMAN said that metatarsalgia was a very common affection. He was surprised to hear Dr. Dawbarn say that the pain was usually worse after removal of the shoes, since in his experience it was almost always the wearing of the shoe that induced the pain. The disability, of which the so-called Morton's toe was but one variety, was due to a depression or laxity of the metatarsal arch of the foot. The indications were to support the arch for a time, to restore the normal strength by exercises, and to wear proper shoes. He thought that operative measures, of

FIG. 1.—Needle in knee-joint.

FIG. 2.—Showing condition of bones of foot ten years after excision of head of fourth metatarsal for metatarsalgia.

which that illustated was the best, were now practically obsolete as a routine treatment.

Dr. Haynes said his own personal experience with metatarsalgia tended to bear out Dr. Whitman's statements. If he pinched his foot in a narrow shoe, the pain was severe, but was relieved by removing the constriction. He had seen the pain in these cases immediately relieved by the use of properly constructed shoes and steel insoles, to quickly return when the support to the arch of the foot was removed.

Dr. Dawbarn said the trouble in these cases seemed to be due to the fact that the normal transverse arch of the foot made by the metatarsal heads was not properly maintained. When this condition was remedied by the use of a proper shoe, tight over the metatarsal bases and loose opposite their heads, the patient would be perfectly comfortable. In at least a dozen cases he had seen, the pain seemed to be more severe when walking in slippers or bare feet than in ordinary shoes. The operation of choice, the radical cure of this condition, was extremely simple, taking only from five to seven minutes, was done absolutely safely and under cocaine, and insured a permanent success. In the instance in evidence to-night the shaft of the fourth metatarsal was nipped across just behind its neck by an ordinary bone forceps. As the radiograph shows, this entails a slight degree of crushing of bone; but it was done ten years ago, before the Gigli wire saw was invented,—the tool to use to-day. It is indifferent which bone, on either side of the nerve being occasionally nipped by their "spurs" coming into juxtaposition, to attack. The cure is certain and instant in either case. And as the X-ray picture also shows, the toe so treated does not sink back. The transverse fasciculi of ligaments opposite the heads will prevent that.

It is, of course, admitted that this is only one form of this trouble,—the case shown to-night; but the cure is equally prompt and sure in all; and hence Dr. Dawbarn thought it preferable to any orthopædic plan, involving years of treatment, and then without any certainty of a cure, unless the appliances are always worn.

Dr. Whitman said that the case reported by Dr. Dawbarn was one variety of a very common disability that existed in every grade of severity. One should aim rather to restore the normal condition than to merely accommodate the part to deformity.

### THROMBUS OF THE LEFT COMMON CAROTID ARTERY.

Dr. Irving S. Haynes, through the courtesy of Dr. M. G. Schlapp, presented a specimen obtained from a case of epithelioma of the lip and chin, for which condition a ligation of the left common carotid was done. A segment became detached from the resulting thrombus, plugged the middle cerebral artery, and produced softening of the brain and death.

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*Stated Meeting, January 25, 1905.*

George Woolsey, M.D., in the Chair.

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### CHRONIC TENOSYNOVITIS.

Dr. Charles H. Peck presented a woman, thirty-five years old, a patient of Dr. Royal Whitman. When first seen last November she presented an elongated tumor, evidently a tenosynovitis affecting the extensor tendons on the radial border of the hand, and another, the size of a small egg, at the bend of the elbow. The duration was about eighteen months, and the disability, of the nature of weakness and discomfort, was increasing. At operation, the two extensors of the thumb and the radial extensors were found to be involved, while that at the elbow surrounded the tendon of the biceps. The affection had been classed as tuberculous, but this diagnosis was not confirmed by the pathologist. The functional cure was apparently complete.

### DOUBLE CASTRATION FOR TUBERCULAR TESTICLE.

Dr. George D. Stewart presented a man, thirty-five years old, who was admitted to Bellevue Hospital in 1901. One of his brothers had suffered from tuberculosis, and his mother had diabetes; otherwise the family history was not significant. He was not addicted to the use of alcoholic stimulants. He had never sustained any injury and has had no illness, with the exception of repeated attacks of gonorrhœa. His first attack occurred nine years before admission, and was treated for nine

months. Almost every year since that time he had had attacks of gonorrhœa, or what appeared to be such, and each of these persisted for several months under treatment.

Four years before admission he began to suffer from pain in the posterior portion of both testes, which disappeared while in the recumbent position. Eighteen months ago he had an attack of gonorrhœa which persisted for about three months, when an abscess in the region of one testis developed. This was opened by his family physician. Since then he had had a number of similar abscesses, the last one in November, 1900. After this was incised, his pain disappeared until early in 1901, when another abscess formed. After this he complained very much of pain in the back and inguinal regions, more severe at night.

At the time of the patient's admission to the hospital, an examination showed that both testes were involved, the left to a greater extent than the right. In both testicles there were discharging sinuses and the pain was constant and severe. On March 20, 1901, both testes were removed, together with the structures of the cord, following them up as deeply into the pelvis as possible, through widely opened inguinal canals. Through the incisions, the enlarged and nodular seminal vesicles could be felt, but they were not removed. The wound was closed, and healed without any trouble. Gross examination of the testicles showed that they were lobulated and studded with caseous nodules, involving the epididymis on both sides, and that both vasa deferentia were involved. The left testis contained many pus cavities. The diagnosis of tuberculosis of the testes was confirmed microscopically.

Since the operation, which was done nearly four years ago, the patient had gained over forty pounds in weight, in spite of his indoor occupation as a tailor. Absolutely no mental disturbances followed the operation. The patient stated that he had frequent erections, although of short duration. There were no signs of a recurrence; no frequency of micturition nor other bladder symptoms, and the urine was normal, showing no evidence of prostatic inflammation.

Dr. Stewart said that when this operation was done, radical measures for the relief of this condition were much more in vogue than at present; and in addition to removing the testes, removal of the seminal vesicles, which were apparently involved,

was suggested, but the patient refused his consent. To that extent, therefore, the operation in this case might be regarded as a conservative one. In cases where the testes were undoubtedly involved as well as the epididymis, and particularly where there were open sinuses, the speaker said he thought the proper and conservative operation was castration.

## TUBERCULOSIS OF THE TESTICLE; EPIDIDYMECTOMY; GRAFTING OF THE VAS INTO THE GLOBUS MAJOR.

Dr. Irving S. Haynes presented a paper with the above title, for which see page 745.

Dr. John A. Hartwell asked Dr. Haynes which operation he would recommend in a case where the testicle was actually involved? Whether he would do a castration or simply scrape out the sinuses? It was very important, he thought, to substantiate the claim that these patients could be cured by a less radical operation than castration, on account of the psychical effects that sometimes followed removal of the testes. In order to show, however, that such mental phenomena did not invariably follow, the speaker mentioned a case that had been brought to his notice by Dr. McWilliams, of the Presbyterian Hospital. The patient was a young engineer, twenty-two years old, who ablated his entire scrotum, including both testes. The reason he gave for this when he was brought to the hospital was that he had previously injured his scrotum by running a nail into it, but he subsequently admitted that he had cut off his testes because they had proved such a source of annoyance to him by interfering with his application to his studies. When the man was seen three years later his condition was apparently normal, and he showed no mental or other symptoms, and no regret at what he had done.

Dr. Benjamin T. Tilton said that his own experience had led him to favor a conservative method of treating these cases. He had seen a number of cases in the early stages of the disease in which epididymectomy was followed by excellent results. He recalled one case in which the sequence of events was as follows: An attack of gonorrhœa was followed by a urethral stricture; dilatation of this was quickly followed by an epididymitis, and subsequently by tuberculosis of the corresponding testis, which was removed. About three years later the opposite testis became in-

volved. It was first treated expectantly, and, finally, an epididymectomy was done. This patient was kept under observation more than four years after the last operation, and showed no signs of recurrence of the disease. The testis appeared perfectly normal, the patient had good sexual power, and his general health was greatly improved.

Dr. Tilton said he had never attempted to graft the vas into the globus major or into the testis, and he thought it would be a difficult matter to bring about such a union as would permit of the passage of semen. In a case that had come under his observation recently, the vas was accidentally completely divided during a difficult operation for hernia. At the suggestion of Dr. Stewart, he sutured it, first passing a catgut thread through each end. An epididymitis developed, but union of the divided ends of the vas apparently took place. At any rate, there had thus far been no change in the size of the affected testis. What the ultimate outcome would be he was unable to foretell.

Dr. Stewart said there were many, including Guyon, who believed that the primary focus of tuberculosis of the testicle was in the prostate, and extended secondarily to the epididymis. The weight of clinical evidence, so far as his experience went, seemed to show, however, that the disease usually began in the epididymis, and extended on the one hand into the testis and on the other into the prostate. When the disease had actually involved the testis, and sinuses had formed, the speaker thought there could be no question as to the advisability of doing a castration; and he did not believe that even the most ardent advocate of epididymectomy would recommend that operation under those circumstances. The only possible reason for leaving the testes under those conditions would be to prevent the possible mental disturbance that might follow their removal.

Dr. Hartwell, referring to the statement in the paper that, in order to produce tuberculosis locally in animals by injecting the bacilli in the circulation of the testes, it was necessary to produce a certain degree of venous stasis, said this was interesting as opposed to the Bier treatment of joint tuberculosis, where a venous stasis was artificially produced in order to inhibit the growth of the bacilli.

Dr. Stewart said he thought the blood stasis artificially pro-

duced by the Bier method of treating tubercular joints was different from that referred to by Dr. Tilton.

Dr. Hartwell said that Dr. Willy Meyer had shown at least one case of tubercular joint disease successfully treated by the Bier method. The stasis was kept up as long as the patients could tolerate it. The principle upon which the method was based was that persons with a chronic heart lesion which produced pulmonary venous congestion rarely suffered from pulmonary tuberculosis.

Dr. George Woolsey said he had been struck by the beneficial effect of climatic and hygienic treatment in the treatment of cases of surgical tuberculosis, especially those of the genito-urinary tract. The results were equally as good as those obtained by operative treatment in cases where there was some bladder or prostatic lesion.

As to the original focus in cases of tuberculosis of the testicle, Dr. Woolsey said he had been led to believe that the epididymis was more often primarily involved than some of the statistics on the subject would indicate. He recalled a possible example of a case originating otherwise in the case of a coachman who gave a history of having injured his scrotum some months previously while jumping onto his bicycle. A swelling developed on the left side, which was tapped by some physician, who then advised operation. Subsequently, when Dr. Woolsey saw him, there was some fluid in the tunica vaginalis; this was of a dark, yellow color, and thicker than the ordinary fluid of hydrocele. After its evacuation, the body of the testis felt distinctly nodular. On exposure by operation, its surface was here and there covered by raised, flattish masses resembling partly organized and decolorized film. Otherwise, the testis was apparently healthy. Some of this tissue was scraped off, and the pathologist reported that it appeared to be tubercular in character, from the presence of giant cells. The gross appearance did not confirm this opinion, and the pathological findings were not positive, and open to question.

Dr. Woolsey said he did not think it was good surgery to leave the testis when it was markedly involved, nor to remove it when the tubercular disease was limited to the epididymis. He had tried the method of injecting these cases with an emulsion of iodoform, but when sinuses and mixed infection existed, it was

difficult to obtain a cure by this method without scraping or some more radical operation.

Dr. Haynes said that before deciding upon the character of the operation in a case of tuberculosis of the testis, the surgeon should endeavor to place himself in the position of the patient, and do as he would be done by. As to the location of the original focus of the disease, he thought the consensus of opinion was that it usually began intertubular in the connective tissue of the epididymis. The older teaching was that tuberculosis of the testicle was a descending infection from the prostate or seminal vesicles, but the speaker thought that theory had been disproven, and that in the majority of cases the infection came through the blood-vessels of the epididymis. Undoubtedly, it could occur as a descending infection, and also, though rarely, through the lymphatic system.

The extent of the involvement in these cases, Dr. Haynes said, should determine the nature of the operation. If the testis was much involved, it should be removed entirely. In one of Murphy's cases, the tunica vaginalis, which was involved together with the epididymis, was dissected off, and the testis itself was left behind. In many cases of unilateral castration for tuberculosis, the opposite testis subsequently became involved.

Dr. Charles H. Peck mentioned a case that came under his observation about six months ago, in which a unilateral castration was done for tuberculosis of the gland. At the time of this operation, the opposite testis was apparently normal, and remained so, as far as could be made out. In doing the castration, the cord was removed above the point of involvement. Several months after the operation, the patient developed a tubercular meningitis, which proved fatal. The speaker raised the query whether there was any special liability to a general infection from a tubercular focus in the testis.

Dr. Haynes said the statistics showed that unilateral castration was followed by only 46 per cent. of cures. In the fatal cases, death was usually the result of tuberculosis in other parts of the body. With a tubercular focus in the testis, it was just as possible for the disease to become disseminated as when the focus was situated in any other organ of the body. In closing, Dr. Haynes spoke of the ease with which the operation of epididymectomy could be done under cocaine anæsthesia. This fact

might be used as an argument to get the early consent of patient to submit to an operation.

## INCOMPLETE NEPHRECTOMY FOLLOWED BY PERSISTENT SINUS.

Dr. Charles L. Gibson presented a specimen removed from a woman, thirty-two years old, who was operated on eight months ago by another surgeon for tuberculosis of the kidney. The kidney, it appeared, was pyonephrotic, and proved so difficult to remove that it was necessary to resect a portion of three ribs before it could be taken out. Following the operation, a sinus developed, which persisted, and when Dr. Gibson reopened the wound he found the pelvis of the kidney which had been left behind by the original operator, and which was the cause of the purulent discharge.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY.

*Stated Meeting, February 6, 1905.*

The President, HENRY R. WHARTON, M.D., in the Chair.

## GANGRENE OF THE SCROTUM.

DR. A. D. WHITING read a paper with the above title, for which see the ANNALS OF SURGERY for June.

DR. JOHN B. DEAVER said his experience has been limited to cases of gangrene of the scrotum due to extravasation of urine; he has never seen a case not due to this cause. They are quite common at the Philadelphia Hospital, where cases of obstruction of urine, and consequently extravasation, are numerous.

## MULBERRY VESICAL CALCULUS.

DR. ADDINELL HEWSON showed a mulberry vesical calculus, together with the bladder, prostate, and penis of the subject from whom it was removed. The man was an Irishman of eighty-three years, an unmarried, illiterate laborer, and a moderate drinker. He died in a poor-house, but had complained of no symptoms whatever referable to the stone. The bladder was found thickened and ribbed, and partially embedded in the wall was the typical mulberry calculus shown. The bladder wall was also the site of two cysts. One was situated in front just above the pubis and was the size of an egg; the second was behind the prostate gland. That organ was enlarged and very firm and dense, but the middle lobe was almost free from involvement. Evidently there was but little interference with urination.

## CHRONIC DUODENAL ULCER; GASTROJEJUNOSTOMY.

Dr. De Forest Willard presented a specimen removed from a man, thirty-eight years of age, who entered Dr. Musser's Service, Medical Ward, Presbyterian Hospital, on account of hæmorrhage from the bowels which had lasted for three weeks. Seven months previous he had an attack of severe pain in right upper quadrant of abdomen. He was in bed two weeks; since then has had frequent but less severe attacks of same pain, and had noticed that his stools had a tarry appearance. Present attack began three weeks before admission, with sharp pain in epigastrium radiating along right costal margin to lumbar region. Nausea, gaseous distention, retching several hours after taking food, with vomiting of small quantities of material which he described as resembling tobacco juice. Appetite poor. Emaciated; extremely pallid; red blood-corpuscles, 2,500,000; hæmoglobin, 23 per cent.; stools contain blood. Examination of gastric contents showed hyperacidity, hypersecretion, and retention; no blood. Stools showed blood. Urine negative. Physical examination, tenderness to right of epigastrium. No tumor.

Diagnosis, duodenal or gastric ulcer near pylorus; possible gall-duct obstruction. Operation following day. Median incision. Hard mass with duodenum, gall-bladder, pancreas and pylorus condensed and adherent. No signs of peritonitis. Removal impossible; anterior gastrojejunostomy with Murphy button. Patient was so profoundly anæmic, hæmoglobin 23 per cent., that additional suture of the two limbs of the bowel could not be done. Operation apparently had no effect, good or bad, and he died from exhaustion three days later with continued bleeding.

Post-mortem.—No evidences of peritonitis; no leakage from gastro-enterostomy; all stitches tight and in good position. Large duodenal ulcer just beyond the pylorus, which had perforated entirely through the coats of the bowel; but before perforation, the gall-bladder had become thoroughly adherent, so that no escape had occurred into the peritoneal cavity. This inflammatory process had thickened and condensed the gall-bladder and its ducts, so that its wall was a third of an inch in thickness and it was entirely empty. The lumen of the button was filled with soft coagula, but no leakage had occurred at the stitches.

DR. W. W. KEEN asked if examination of the blood had been made after the operation. The hæmoglobin before operation was 23 per cent., below the limit of safety as placed by von Mikulicz. Death apparently was not connected with the anæsthetic, and a blood count might have thrown further light upon the matter. The anæsthetic would reduce the hæmoglobin to some extent.

DR. E. B. HODGE, who exhibited the specimens for Dr. Willard, said no blood examination had been made after operation. Small quantities of blood were passed by the mouth and by the bowel, but the patient was more comfortable for a day or two. He then gradually failed, and died of exhaustion sixty hours after operation.

## SENILE ATROPHY OF CRANIAL BONES.

DR. DE FOREST WILLARD presented the skull of a man, seventy years of age, who, after a fall down-stairs, became totally unconscious, with stertor, and slow pulse. Operation without ether, and with no signs of pain. Entire left side of skull found broken into a dozen pieces, brain crushed, and oozing from openings in dura.

This great destruction was due to the extreme thinness of the cranium, which in many places was infantile in thickness and exceedingly fragile. Many fragments, an inch square, were removed, but patient never recovered consciousness. With a skull so atrophied, a very slight injury would have caused a fracture.

## AN EXPERIMENTAL AND HISTOLOGIC STUDY OF CARGILE MEMBRANE.

DRS. A. B. CRAIG and A. G. ELLIS, by invitation, read a paper with the above title, for which see the ANNALS OF SURGERY for June.

DR. W. M. L. COPLIN said the detailed experiments were to him interesting from two points of view: 1. From the purely scientific aspect of the question, and, 2, when viewed in the light of our knowledge regarding the healing in of foreign bodies. As a result of constant findings, the pathologist cannot regard a dead organized body as being other than an irritant when placed in the tissue. This is true even of isolated tissues in the body from which they are derived, detached periosteum or fragments

of bone acting as irritants to the surrounding structures. Because of this action, reintroduced tissue, in essentially every instance, is eventually absorbed and replaced by newly formed tissue. An interesting point is the method by which this absorption is accomplished. Following the studies of Metchnikoff and his school, there was a tendency to lay stress upon the action of phagocytes in the removal of the foreign body. The introduction of the celloidin capsule method of studying the effect upon bacteria of the body juices has furnished evidence, however, that lytic substances are present in the body fluids. This study of Cargile membrane appears to be the first investigation of the action of lytic substances upon foreign bodies in the tissues. Ziegler and his students have investigated the exudate cells found between embedded cover glasses, but in the experiments made by Drs. Craig and Ellis no cells could enter the capsules containing the membrane. Yet the membrane was destroyed or in process of solution, though no cellular bodies were in the fluid. In view of the question as to whether this process is a fatty degeneration, the contents of the capsules were very carefully examined for fat, but none was detected. The trend of opinion now is to look to the action of lytic substances in the destruction of irritating bodies, whether they are the cells of animals or actual foreign bodies that have been introduced. The absence of applied phagocytes in the present experiments is significant. Müller, in his studies of the absorption of teeth, and others have found the destroying cells applied to the tissue to be removed where they appear to secrete a material that destroys the tissue. Here the giant cells are not applied to the membrane; disintegration, however, is proceeding, an indication that lytic substances—possessing some of the attributes of familiar enzymes—are at work. Whether or not these substances come from the cells of the new tissue is a question at present under discussion; such origin is probable. The experiments make it clear that Cargile membrane acts as a foreign body, the chromicized and unchromicized varieties appearing to be equal in this respect. The practical application of the membrane, as to its harmful or beneficial effects upon the tissues, must of course be determined by the surgeon.

Dr. W. W. Keen said that, viewing the experiments from the practical side, the surgeon finds negative facts as important as positive results. The value of the paper lies in showing that

the confidence of surgeons in Cargile membrane is largely misplaced, as it does not prevent adhesions. Dr. Keen would like to see the experiments continued and applied to several other materials. Silver and gold leaf both have been used in the cranial cavity, and found still present after long periods of time; can they be used elsewhere? The value of thin rubber dam and gutta-percha tissue should also be tested in this regard. Finally, the elastic rubber plaster employed by Brewer in his experiments to wrap arteries requiring repair of a solution of continuity should be tried to see if it would prevent adhesions. Good results were obtained by Brewer in the case of the arteries, though Dr. Keen is not sure that microscopic studies of the tissues were made. Continued studies will probably lead to the discovery of other substances that will be efficacious and more satisfactory in preventing adhesions.

Dr. John B. Deaver said he had used Cargile membrane quite extensively, in at least fifty or sixty abdominal sections, in covering denuded surfaces, stumps after hysterectomy, etc. His attention was first called to the material by the paper of Dr. Morris. All the patients upon whom Dr. Deaver used the membrane recovered, and, as reoperation was not necessary, the effects upon the tissues could only be surmised. The recovery of these patients was as uninterrupted as in case of those upon whom the membrane was not employed. Dr. Deaver never employs the membrane to cover raw surfaces if he can obtain a peritoneal or omental graft. From the manufacturer's stand-point, the membrane employed was in every instance aseptic.

Dr. Craig, in closing, said, in regard to the recovery of patients within whose abdominal cavity Cargile membrane was employed, that the material disappeared so rapidly it would probably not interfere with recovery. He has used the membrane in dispensary practice to cover open wounds, as ulcers, and in skin-grafting after the Reverdin method, and finds it is destroyed very rapidly over the raw surfaces.

## RUPTURE OF THE TENDON OF THE BICEPS FLEXOR CUBITI.

Dr. W. W. Keen presented a patient upon whom he had operated successfully for the relief of the disability caused by this accident, and read a paper upon the subject, for which see page 756.

Dr. Gwilym G. Davis said that since reporting his series of cases he had found one in a dissecting-room subject which supported the theory of the rupture of the tendon being due to disease of that structure. In the instance mentioned the tendon where it lay in the bony groove had almost entirely disappeared. Operation is indicated in cases of this injury in healthy individuals, provided they are seen early. Reasons why more cases of this injury are not operated upon are: 1. They are not seen early. 2. The disability often is comparatively slight, the other head of the muscle assuming the extra function. 3. The injury often occurs in people of rheumatic diathesis. It does not follow that severe trauma is necessary to cause rupture, as the tendon is often reduced to a mere thread. When such cases are operated upon, the tendon must be transplanted to the other head of the muscle.

Dr. Keen, in closing, said Dr. Davis's dissecting-room specimen was not subject to the criticism of specimens of supposed rupture of the muscle found in such bodies; the latter are more likely due to stretching, incident to moving the arms when rigor mortis is present, than to ante-mortem causes. In one case good results were obtained from operation three months after the injury, but if possible early operation is desirable. In cases not operated upon, the disability eventually is often quite marked. In the papers referred to are reported cases of laborers, porters, and soldiers who were rendered incompetent to perform their accustomed work. Only a few cases exhibit but little disability.

# TRANSACTIONS

OF THE

# CHICAGO SURGICAL SOCIETY.

*Stated Meeting, January 16, 1905.*

DR. L. L. MCARTHUR in the Chair.

## STRICTURE OF THE ŒSOPHAGUS.

DR. D. N. EISENDRATH presented a man who began to have difficulty in swallowing, with regurgitation of food about one year ago, necessitating, finally, the performance of a gastrostomy, done in New York, with apparently a good result. An œsophageal bougie could not be passed beyond the level of the junction of the manubrium with the gladiolus. He had the patient swallow a large amount of bismuth, and then made a radiograph, which showed the obstruction, and to the left of it a tumor. The obstruction was a saccular one. After the passage of steel sounds the man was able to swallow milk, but at present he was feeding himself through the gastrostomy wound. This case showed the value of the X-ray and bismuth for diagnosing these conditions.

DR. A. E. HALSTEAD stated that the tumor which showed in the radiograph of Dr. Eisendrath's case probably was a diverticulum, although it might be an aneurism. The point of the obstruction was one of the favorite locations for a diverticulum. Strictures also developed at that point; but in the absence of a cause for stricture, it was probable that the tumor was either a diverticulum or an aneurism. Skiagraphing these diverticuli with bismuth was not so good as passing a soft rubber tube filled with shot and then skiagraphing.

DR. EISENDRATH stated that he had examined his patient

repeatedly, but failed to find any evidence of aneurism or tumor, and he was, at present, unable to differentiate between aneurism, tumor, or diverticulum. The resistance encountered when passing bougies was so great that he suspected the condition was one of tumor rather than diverticulum. The patient was failing rapidly, which would point to a mediastinal tumor, probably a malignant one.

## ACTINOMYCOSIS OF JAW.

DR. WILLIAM HESSERT presented a girl, aged fifteen years, who a few months ago presented herself with a history of toothache and a swelling of the right jaw. A decayed tooth was visible, and the trouble seemed to be a necrosis of the jaw with cellulitis in the surrounding tissue. He operated, but failed to find pus. There was a hard, indurated mass, the bone being denuded. The wound healed up, but the tumor increased in size. Later, small areas of softening appeared, three or four of which he incised, and in the discharge he found the ray fungus. He put the girl on large doses of potassium iodide, and she was improving steadily. The mass had diminished in size about one-half, and she could open her mouth better than ever before. She was taking as high as eighty grains of the iodide a day, taking it for alternate weeks. There had been no glandular involvement.

DR. W. M. HARSHA said that he had seen two cases of actinomycosis in the past year, and the tissue around the broken-down masses was very hard, almost gristly. That condition was so marked that he considered it a valuable diagnostic sign. He also mentioned the value of following the operative procedure with exposures to the X-ray, inasmuch as it would remove, or at least aid in removing, these growths.

## METASTATIC RENAL ABSCESSES.

DR. HESSERT presented a man who some years ago had a necrosis of the right femur, necessitating its amputation a few inches below the trochanters. Later, he had some abscesses of the back. The trouble in the jaw was diagnosed as an osteomyelitis. An incision was made and a small amount of pus was evacuated. The patient did well for about ten days, when he began to complain of pain in the right lumbar region. Re-

peated examinations of the urine finally showed a small amount of pus. The right kidney was increasing in size and became tender. The general condition of the patient was indicative of sepsis, and a diagnosis of suppurating right kidney was made. The kidney was removed and showed a number of abscesses in the cortical portion. The pus was found to contain the staphylococcus pyogenes aureus. The patient did well for a while, but finally complained of pain in the left kidney, which became large and tender. Pus showed in the urine. An incision was made and many abscesses were found in the cortex of the kidney. These were evacuated with the finger, the wound was packed, and the patient made a slow but uneventful recovery. He was gaining in weight.

DR. EISENDRATH extirpated a kidney about five years ago for ascending pyelonephritis with multiple abscesses in the kidney, and, later, doubted whether he did not make a mistake in doing so. Fortunately, the patient recovered without further symptoms. He said that Weir, of New York, called attention to the fact that surgical kidney frequently was a unilateral process; whereas, in the case of multiple metastatic abscesses the condition was quite likely to be bilateral. He referred to an article which appeared in the *Münchener medicinische Wochenschrift*, in which the writer spoke of opening the abscesses, evacuating and draining the infected kidney. His own experience, this article, and Dr. Hessert's case would lead him, in the future, to adopt that procedure because the kidney was known to have great recuperative powers.

DR. A. H. FERGUSON referred to a case he reported some years ago of multiple abscesses of the right kidney, where he excised some abscesses and opened others. The other kidney became involved two years later, but the patient refused operation and died from sepsis. In the kidney operated on no abscesses developed subsequently, leading strength to the practice of not extirpating such kidneys. The first thing to do in such cases, whether of ascending or metastatic variety, was to ascertain the condition of the urine from both kidneys. It furnished valuable proof of the condition of the other kidney, and also indicated the time of interference. His own practice was to open such kidneys and evacuate all the abscesses, draining externally until there was no more pus in that kidney. The progress of the second kidney

in Dr. Hessert's case, he said, would indicate that, if the same treatment had been pursued with the first kidney as with the second, there would now be more kidney secreting power.

## BRAIN TUMOR.

Dr. John E. Owens presented an account of a cerebral sarcoma removed by operation, for which see page 655.

Dr. Eisendrath said that one of the difficulties encountered in performing these operations was the bleeding from the scalp. In a case he operated on for Jacksonian epilepsy, the bleeding became so severe that the patient was almost exsanguinated. Another point was the hopelessness of these cases, especially the sarcomata, because they were not encapsulated. In his case he succeeded in relieving the intracerebral tension, but the other symptoms did not seem to be much relieved. A third point was the frequency of occurrence of hernia cerebri. He had seen a number of cases in which it was almost impossible to keep the bone flap in apposition with the remaining portions of the skull.

Dr. Ferguson stated that he had operated on quite a number of such cases, but in none of them had he any such good results as Dr. Owens had in his case. He merely succeeded in securing temporary relief from the headache. The hernia of the brain became enormous. He had never failed to control the hæmorrhage from the scalp without the use of the elastic ligature, which he discarded long ago. He depended entirely on a sufficient number of hæmostats and pressure. In one case, however, he had a fatal hæmorrhage from the diplöe. In spite of packing dermatol into the diplöe, crushing the bones together, and packing the wound, the hæmorrhage continued. Although a large flap was useful, he said that he had discarded it, making two or three small flaps with their bases in different directions, and it appeared to be an advantage over a large flap.

Dr. Wagner said that hæmorrhage from the flap occurred more often than was supposed. He mentioned a device published a year ago which was very simple and reliable. It consisted in putting in two rows of sutures, between which the incision of the scalp was made. These sutures were left in place until the wound had healed. They had not been found to interfere with healing by shutting off the blood-supply.

DR. HALSTEAD said that he had made use of this method fifteen years ago under the direction of Dr. Jacob Frank, who claimed to be its originator. He had discarded the method, however, because it took up too much time and did not give much security against hæmorrhage. He had found that, as a rule, the hæmorrhage could be controlled with artery forceps and pressure. A few years ago he operated on a case of brain tumor at the base of the skull for the purpose of relieving the pressure symptoms. He made a trephine opening and evacuated the ventricles. The intracranial pressure increased enormously, so much so that the brain tissue was forced out through the small opening through which the fluid was withdrawn from the ventricles. By tapping the ventricles, the patient's condition was improved and the pressure was relieved. He learned later that this was not an unusual complication of such operations,—in fact, the acute œdema of the brain sometimes caused death. His patient lived for a few months. He said that, to relieve intracranial pressure, an opening should be left in the skull. The osteoplastic method was contraindicated.

DR. STEELE stated that, while the ultimate outcome of Dr. Owens's case was as yet in doubt, the temporary relief and the prolongation of the patient's life were of value. He referred to an intracerebral sarcoma, about two inches in diameter, which he published about two years ago. The location of the tumor in the motor area was easy, and its removal was not difficult. While there was no difficulty in controlling the hæmorrhage from the scalp, the hæmorrhage from the longitudinal sinus was severe. He packed in an abundance of iodoform gauze and succeeded in controlling the hæmorrhage. The patient was still alive after twelve years.

DR. OWENS said that hernia of the brain could be prevented by making an opening in the dura at the base of the flap, when that was possible. That could not be done in his case because of the natural opening at the top made by the tumor. The hæmorrhage in his case was exceedingly troublesome, but encircling the scalp with the elastic ligature proved very satisfactory. The blood-vessels were much dilated, which, of course, favored the hæmorrhage. There was not so much brain tissue in a cerebral hernia as was often supposed. As a rule, it consisted of granulation tissue and a little brain tissue.

There was also considerable infection in his case, and, as he wished to get a union of the bone flap in part, at least, he had to make use of the gold plate. In pressing it down, some pus came from the depths of the wound. This was carefully dipped out and, fortunately, the case got along nicely.

## HYDROCELE IN THE FEMALE.

DR. A. E. HALSTEAD and DR. CHARLES P. CLARK read a paper with the above title, for which see page 740.

DR. OCHSNER said that he had never encountered a sacculated body in hydrocele in the female. He emphasized the value, so far as diagnosis was concerned, of the points brought out by Dr. Halstead; but after one had made a diagnosis of this condition a few times, it was not a difficult matter. In one case the dumb-bell-shaped hydrocele gave him considerable trouble, because it seemed to be a hernia filled with peritoneal fluid in connection with a tubercular peritonitis. The filling up of the outer sac seemed to be similar to one he had seen previously in a case of tubercular peritonitis complicating hernia, and the quantity of fluid was sufficient to give rise to the error in diagnosis.

DR. MCARTHUR failed to see how it was possible to differentiate between an empty hernial sac and a hydrocele in a case where the canal of Nuck contained fluid which might be emptied into the peritoneal cavity. It might be one or the other condition. A few years ago he operated on a case that he supposed was one of hernia, and which answered to this description. It consisted of a tumor, tense, impulse on coughing, slowly reducible, appearing on standing, disappearing on lying down. On opening the tumor he found it to contain a clear straw-colored fluid, which, on examination, was found to contain one-fourth of 1 per cent. of urea. The tumor had a small communication with the peritoneal cavity, through which the omentum could be seen trying to escape. He considered that as much a hernia as a hydrocele, in which the hernial sac was probably congenital, but the neck of the sac just too small to permit of the escape of the solid abdominal contents. He had sections of the sac examined by Dr. Zeit, who reported that it probably consisted of an offshoot or diverticulum of some of the hollow abdominal viscera because it was lined with epithelium, and out-

side of this were muscularis and serosa. The patient made a perfect recovery.

DR. HALSTEAD said that congenital hernia did not mean that there was either gut or omentum in the sac at the time of birth. The hernia might not occur for twenty-five years, and yet, when it did occur, it was a hernia. But until something came down, it was not a hernia. There were two cysts in this region, —one an accumulation of fluid in an old hernial sac, which was not a hydrocele; another, a cyst in the round ligament, communicating sometimes with the peritoneal cavity. Several such cases were on record, and that, he thought, might explain Dr. McArthur's case.

## CALCULI IN COMMON DUCT AND BILIARY PASSAGES.

DR. L. L. MCARTHUR presented the history of a case of stone in the common duct.

The patient, M. G., aged twenty-five years, clerk by occupation, Austrian by birth, was admitted to the Michael Reese Hospital, November 28, 1904. Family history: Father living; mother dead, cause of death unknown. One brother and sister living. Family history negative. Past history: Patient always well and strong.

Present trouble began ten days ago. Patient states that he caught cold ten weeks previous to onset. Onset was sudden, with severe cramp-like pain in the right hypochondriac region. Pain localized and aggravated by deep inspiration and coughing. Tenderness on pressure. No icterus. Had a chill third day after onset, followed by elevation of temperature. No nausea or vomiting, although an emetic was given to induce vomiting. Appetite good until late. Bowels usually regular. No hæmatemesis; no melena. Coughs some, the cough being of a dry, hacking character. Slight expectoration; no hæmoptysis; no night sweats. No urinary trouble; no venereal history; drinks some, but not to excess.

When patient entered the hospital, the physical examination showed only a slight tenderness in the epigastric region just below the ensiform cartilage. The skin chocolate-colored. Spleen palpable; temperature, 102.4° F. (rectal); pulse, 92, and respirations, 20. Leucocyte count, 10,300. During his first

ten days in the hospital, the patient's temperature ranged from 99° to 103° F. On the tenth day he had a chill which lasted fifteen minutes, followed by a sudden rise of temperature to 105.6° F., dropping to 102.6° F., in an hour after being sponged, the pulse ranging all the time from 70 to 90. Six days after coming into the hospital, the patient had an attack of severe epigastric pain, with a slight icteric hue to the skin. A small round tumor, about the size of an egg, was felt in the region of the gall-bladder. The rectus muscle was tense on the right side. There was no radiation of pain to the shoulders, but it passed to the back and in the lower thoracic region. On the twelfth day he had another chill, followed by a temperature of 105.6° F. Leucocyte count, 19,000. On the following morning he was operated. Urinary examination showed albumen, bile, hyaline, granular and epithelial casts.

At operation, a sausage-shaped tumor was found in the location of the common duct. It was hard and firm, and felt like the displaced bodies of the vertebræ, but it was movable. It contained many stones tightly impacted. The gall-bladder was aspirated and a bile-stained fluid evacuated. The common duct contained a mucopurulent fluid having the appearance of appendicitis pus. With the fluid numerous stones of good size and resembling stones usually seen in the gall-bladder were washed out. One hundred and forty-six stones were removed. The patient died on the third day after the operation from sepsis. On section of the liver, stones were found in all the biliary ducts.

Gross specimen of the liver was shown.

## DISLOCATION OF THE ATLAS.

Dr. D. N. Eisendrath showed a specimen which illustrated the mechanism of rotary dislocations of the atlas upon the axis. It was obtained from a boy who was thrown from a bicycle, striking upon his head, and who died within a few minutes after entering the hospital. Death had been caused by compression of the cervical portion of the spinal cord through the slipping backward of the odontoid process. The specimen illustrated the fact that this variety of dislocation, which probably is one of the most frequent, causing a tearing of the ligaments binding the articular processes of the atlas and axis together, permitting of their rota-

tion upon each other. At the same time, the transverse ligament was torn, allowing the odontoid process to slip backward.

## SYPHILIS HEREDITARIA TARDA.

DR. EISENDRATH showed a boy, sixteen years of age, with a marked enlargement of the left tibia, greatly resembling a periosteal sarcoma. The X-ray picture showed a greatly thickened periosteum, and inquiry revealed the probability of syphilis in the parents. The case was one of those forms of hereditary syphilis which do not begin to show themselves until the age of puberty, and at that time affect especially the periosteum of the long bones, to which Fournier has called attention. The presence of nocturnal pains led to the suspicion of syphilis. The administration of iodide of potassium in five-grain doses for ten days caused the disappearance of these night pains, and a diminution in size of the affected bone.

## PRIMARY TUMOR OF THE TESTIS; METASTASIS IN HEAD OF FEMUR.

DR. EISENDRATH showed an X-ray of the pelvis and both femora, in which the head of the left femur was entirely destroyed through the presence of a metastasis from a primary tumor of an undescended testis. The primary growth had occurred in an undescended testis, in association with symptoms of strangulated hernia. On operation, which was performed by Drs. Leeming and Eisendrath, the symptoms of strangulation were due to a torsion of the undescended testis, which was greatly enlarged and hæmorrhagic. The tumor was not suspected to be malignant. About a year later the patient complained of severe pain in his left hip, with nocturnal rise of temperature, and shortening of two inches. The X-ray showed the destruction of the head of the bone, and, on opening the hip-joint, a number of grape-like tumor masses were found which showed upon microscopical examination the nature of the primary growth, that is, a mixed tumor of the testis. The case was of especial interest, showing the tendency of some secondary tumors to localize in the head of the femur.

# REVIEWS OF BOOKS.

HAND-BOOK OF SURGICAL ANATOMY. By G. A. WRIGHT and C. H. PRESTON. Philadelphia: P. Blakiston's Son & Co.

In this little volume of 200 pages the authors have grouped together a series of anatomical facts, and with each of these they have associated a surgical condition. Although there is nothing original in such a work, the authors have selected the most important points in surgical anatomy, and have dealt with them in such a concise manner that the student may obtain much valuable knowledge in a short space of time. This method of intermingling the study of anatomy and surgery is evidently followed in the Manchester School of Medicine in England, for the students of which institution this book is intended as an aid.

WALTER A. SHERWOOD.

REGIONAL MINOR SURGERY. By GEORGE GRAY VAN SCHAICK. Second Edition, Enlarged and Revised. 228 pp., Cloth. New York: International Journal of Surgery Company.

The first edition of Van Schaick's "Regional Minor Surgery" was reviewed in the July number of the ANNALS OF SURGERY for 1903. The reviewer can emphasize again what was said of the book at that time.

The text has been subjected to a complete revision, and additional material has been included so as to bring it up to the present date. That the demand has so soon made necessary a second edition evidences the deserved favor with which this little volume has been received.

WALTER A. SHERWOOD.